timber for building

turning trees into houses

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about the author

Even as a boy I had some sort of yearning for the practical life, although at that age I was not aware of it. Like many other authors I have the feeling the education system failed me badly and this caused many problems until as a mature student I attained a degree in forestry and the skills to be able to write my books.

The sixties brought the concept of sustainability on a global scale into the spotlight, and the well-deserved distrust of governments and their political manoeuvres. The many wars within the twentieth century and the impending threat of nuclear devastation from the cold war had huge impact on everyone. It was in this climate of uncertainty that the ideas of sustainability, self-reliance and survival were welded together within the thoughts of many people. This disaffection and distrust was clearly reflected in the popular culture of the time with films like *Mad Max* and *Max Headroom 20 Minutes into the Future* reflecting these concerns. So that's it; don't trust them if you have a choice – and make the choices so that you stay as free as possible.

To that end there is a clear path of rejecting the popular path of go to work for 40 years, pay through the nose for everything because you do not have time to learn as you are working all the time, then die of exhaustion.

The alternative was to gain skills and not to be beholden to an organisation, so that (I think) is where my perspective comes from, and it gets easier as time trickles (or rushes) by, whereas the alternative just gets more difficult as you are totally reliant on members of the finance industry to support you and, as we know, they can hide behind a corkscrew.

So skills are attained slowly with much practice, but there are many rewards along the way. This is what my books are about; giving the information to help people increase their self-reliance. My Youtube channel videos are uploaded for the very same purpose, but there is a problem in that it goes against first principles. Namely the channel existence is reliant on big organisations and their short-termist views; so I produce and upload them with no expectation of permanence except within the minds of some individuals.

The self-reliance life view can also free up some time now, and time now is more valuable than a promise of time in the future because you might get that tap on the left shoulder (see later in the book and then this will make sense).

Gives you time to sort the mouse droppings from the peppercorns.

introduction

This book although primarily about conversion of logs into usable posts, boards, battens, planks, studs and other scantlings, is also a text upon which to hang all those little bits of information and curiosities that are collected over decades of working in both the joinery and forestry industries. Examples of these are such as, why would you be cautious when thinking about air- or kiln-drying wide Corsican pine boards, or what would make you think twice when buying sweet chestnut with a mid-length diameter above something like twenty inches that has been grown on a sandy heathland site?

When looking around in the built environment we realise we are surrounded by timber products, and as such they are valued more highly than their modern imitations or substitutes. These timber articles, that vary from desks, chairs, roofs, floors, fences, sheds, buildings, transmission poles and firewood, all start with trees being grown under various intensities of management.

Silviculture is the name given to the art of growing trees, and it is an art – a four dimensional one at that, as the length of time taken for a sapling to mature can be between thirty and two hundred and fifty years depending on the species, site conditions, size required and management type. This means that it is a rare occurrence where those that planted the trees see the whole process and so for most foresters we are just part of the journey, trying to do our best with the legacy left by previous generations and the economic and physical environment of our days. Trying at best not to let the side down and to be able to leave the woodlands in equal or better health than that we inherited.

The conversion of logs into usable timber covered in this book is on a small scale, where the final user has done the conversion or employed a contractor with specific equipment suitable for the size of logs. The practicalities of the various machines and equipment are discussed, as is the need to be self sufficient in this initial stage of using timber for building and joinery.

How the wood is dried is important to prevent shrinkage and movement of the finished article, and so both air- and kiln-drying are covered using home made, small-scale methods.

There is a blurred line between the end of producing timber for use and the start of any construction. The transition point comes when you are planing and machining sections (pieces of timber that have been machined to a specific size and shape), say, for the building of windows. For this book I have decided to put an arbitrary limit at planing, by hand and machine, as at that point the planed timber could be used for anything but beyond that stage the machined or hand-formed sections become project specific.

So why would anyone want to go to all the hassle of converting round wood into sawn material? Well for a start there is the saving in material costs, plus the true use of local materials and the benefit of using the materials that you wish to as opposed to those that are available. It's very easy to go to a timber merchant and buy imported redwood (Scots pine) from the Baltic or whitewood (spruce) from Scandinavia, but you pay for it, accept the sizes available and the quality, and it's not local or contributing to the local economy. By buying imported timber you are also contributing to the risk of importing diseases and pests like Dutch Elm, Sudden oak death, Asian Longhorn Beetle, or the Oak processionary moth, and others.

As you continue to read it will become clear that using wood for building is more than just something to earn a living, it becomes a passion on the trail of the ideal balance between material, environment and form. Building things yourself from materials gained in this way also improves your self-reliance and confidence. We are all born as financial slaves and you have to buy your freedom unless you are born into a family that has previously either earned or stolen its financial freedom. Avoiding costs by being self-reliant gives you the chance to husband your resources and reach a point where you neither pay rent or a mortgage. This is, to my way of thinking, freedom and just as in the past where slaves could buy their freedom, we have to do the same.

So this book is about using local timber, converting logs yourself, using the timber and enjoying the process – in the words of one of my local timber hauliers 'steady away' and we will gradually put a picture together of how to go about this process.

growing trees, structure and knots

As highlighted in the introduction, the growing of trees is time consuming, and I like to call this a four-dimensional process even though many people would hasten to argue the point. Foresters are seeking to use the natural ecological processes to encourage trees to grow in such a way as to produce timber suitable for building, joinery and furniture making. Now I do not want this book to turn out to be a silvicultural text and I have a feeling it may do unless I pay particular attention. However I feel that a brief introduction into this subject would give insight into how foresters arrive at a particular timber quality. Let's start with some basic tree growing facts.

trees for timber need to grow with a single straight stem

Trees grow in the ground but not out of the ground. In other words from the top up; that is to say the leading shoot does all the growing and controls the process. This control by the leading shoot is called apical dominance, and is a bit like a dictatorship where all the lower shoots must do as they are told. Occasionally, depending on the tree species, there will be two leading shoots and they either battle it as dictator and the freedom fighter, or develop in harmony. The quality of the timber is rarely as good as in a single stem unless we are talking about firewood.

how trees grow

The leaves capture atmospheric carbon and convert it through photosynthesis into the building blocks of the tree's structure. Photosynthesis breaks down carbon dioxide and water, and then combines some of these products to form bits of tree. That is cellulose for the cell walls and lignin to bind the individual cells together. So in other words trees are made from air and water and, because of this, the speed of growth is dependant on the leaf area of the tree and the water available (up to the point of ground saturation). The larger the crown, the more leaves, the more carbon and sunlight is captured, the quicker the potential growth.

how to get a long straight stem

The apical dominance of the leading shoot is always growing towards the light, so if there is an ample supply of light then in many species (particularly oak) the need to grow tall becomes less important than the need to spread the crown to capture as much carbon and sunlight as possible. Hence if you observe parkland-grown oak trees the main stem is quite short but there is a huge, spreading crown. As timber users it is the main stem we are especially interested in, although the large branches have sufficient volume for lesser quality produce or specialised uses like boat building. It is here that the branches curve and so the curve in the grain gives strength to curved structural timbers like boat ribs.

a knot-free stem is important

Branches allow the crown to expand and create a larger photosynthetic leaf area but branches also create faults and stress within the tree. In sawn timber knots will cause many problems and the importance of these depends on the final timber use. Knots and the associated problems are covered in detail elsewhere. There's a thing called allocation of photosynthate, meaning the priority the tree gives to where the products of photosynthesis are allocated. The general rule is that height takes first preference so that a tree can compete with its immediate neighbours. Beyond that the priorities are (in order) leaves, shoots, seeds, branches and then girth (diameter of the main stem). It's the girth and height that the foresters are interested in, along with quality. An extra to this is that branches need to support themselves; not only mechanically but by means of the photosynthetic food they produce from the leaves on that branch. So if there are insufficient leaves or the light levels are too low then the branch will die off. This is a benefit I'll discuss later, as well as dead and live knots.

trees growing in woodland

Trees like to grow together for protection from exposure, the creation of microclimates for young trees and the protection to some extent from both mammalian and insect pests. The woodland soil is very specific to the local geology, being very high in organic matter and fungi compared with open or agricultural soils. The trees and fungi have a symbiotic relationship where they mostly work together to swap nutrients and minerals.

To take these basic rules and use them to grow good timber the forester first makes sure that the trees of any specific age are approximately the right distance apart. This is done initially by planting at the right spacing or making the conditions ideal for natural regeneration from an on site seed source. As the trees grow the application of a combination of apical dominance and allocation of photosynthate means that the trees will be growing up to the available light, Height will be favoured over branches and stem diameter, so the branches will be of small diameter and the lower ones will quickly be suppressed as the tree cover closes and reduces the available light reaching the ground. It is important that these lower branches do not get too large and that they die off when the stem has a relatively small diameter. This means that the dead branch (having a small diameter) has no natural durability, falls away quickly and all new growth beyond that diameter is knot free.

Foresters apply these basic rules in various ways depending on the tree species. There's an estate owner I know, Jonathan, pleasant old gent, he is really into his poplar trees. Now poplar needs to be set with quite a wide spacing because it is a light demander (needs good light to grow well), commonly six to ten metres apart. Due to this, and the need to maintain the land underneath to prevent encroachment of bramble and the like, the trees are commonly set in a regimented grid pattern. Jonathan took this to its logical conclusion on one planting block and the trees were planted on a grid pattern, in line from several directions. I put forward the idea that a series of photos over a few years should be entered for the Turner prize. It really was a four dimensional space as, due to the initial wide spacing and therefore less light competition, there is a need to prune the trees to remove developing side branches. This type of pruning was very common up until the 1950s as poplar was grown for Bryant and May for the match industry, and also for peeler logs to make vegetable packing crates. Good, clean, knot-free timber was required to make match production possible. The logical conclusion was to take the pruning to an exact height, so that the underside of all the crowns were of the same height. I had the thought that this was landscape art, and to add the time element over, say, something like fifteen years in photographic form would be impressive. Nice idea, but doubt if it came to fruition.

The term light demander is matched with shade tolerant, and variations between the two extremes. So different tree species have different growing strategies, and this is all part of the silvicultural characteristics, where tree species are matched to individual sites. This takes into account geology, exposure, altitude, latitude, and tree spacing along with a thinning regime.

fig 1: late pole stage sycamore before second thinning

Just to push this subject a bit further, as the trees grow up those that are most suited to the site will grow faster and so become dominant but at some point the competition in the canopy will have a detrimental effect on virtually all of the trees. They will become too drawn up with small crowns (branched and leafy tops) and growth will slow down or stop.

Before this happens is the time for the first thinning where the poor form (badly shaped stems and crowns) are removed to allow the remaining crowns to expand and take up the newly available space. Where there is competition in the canopy the crown size is restricted by two things; the available light and the physical damage to buds as they bash into the crowns of the surrounding trees on windy days. I have seen many times the effect of a thinning regime in the annual rings in timber or on a stump. The growth starts off quick with wide rings that gradually get narrower as the full potential of the light becomes used. After a thinning the annual rings get wider until competition reduces growth again, see fig 7 on page 25. I'll stop right there, as this could go on for several centuries.

fig 2: closed canopy

softwood and hardwood

There is a perception that hardwoods are durable and softwoods are not, and this is about as incorrect as an incorrect thing can be. There is no such rule, as some trees that you would think of as a hardwood turn out to be classified as softwood. Yew for example is as hard as nails and mighty durable, and has needle-like leaves that stay on all year long, however it is softwood. Poplar that is about as durable as a political guarantee and with timber that looks like softwood is classified as a hardwood; admittedly it is deciduous (loses its leaves in winter) and has broad leaves. Larch is deciduous and some varieties (European) are quite durable but it turns out to be softwood. Apparently it's all to do with the seeds, whether they are exposed or covered with a fruit of some weird and wonderful variety. No point getting too deep into this facet of classification as really from a timber and woods person's perspective the important things are the working properties, durability and market price.

tree structure

The basic building block of a tree is the cell, the walls of which are made mainly from cellulose. This is created by the tree from the sugars produced through the process of photosynthesis. Hardwood and softwood cells are different. Hardwoods comprise of long tubes with porous sieve ends that are connected end on end, whereas softwoods have a trapezoid or lozenge shape with valves in the sides and are called trachieds. These cell structures are called fibres in the timber and forestry world. The cell walls create the structure and strength of the trees whilst the inner area creates a passageway for the movement of liquids throughout the whole tree. This liquid is either water and dissolved nutrients and minerals drawn up from the roots, or dissolved photsynthate moving from the leaf areas to help sustain the tree through growth or respiration. This subject is also covered in one of my other books *heating with wood*, where it is used to describe the effect of cell structure on the drying process in firewood.

The path of the liquid is obvious in the hardwood cell, but there are also openings in the side of this tube to allow for sideways movement. This is particularly important when there is mechanical damage to the tree and this feature allows the tree to sustain those areas above the damage.

With the softwood cells the path of the liquids is serpentine in that it moves from cell to cell through the side wall valves call pits. The valve-closing disc within the pit is called a torus, and this seals off the cell if there is damage in the adjacent cell. The cell structure affects the way timber dries and this is covered later in the book.

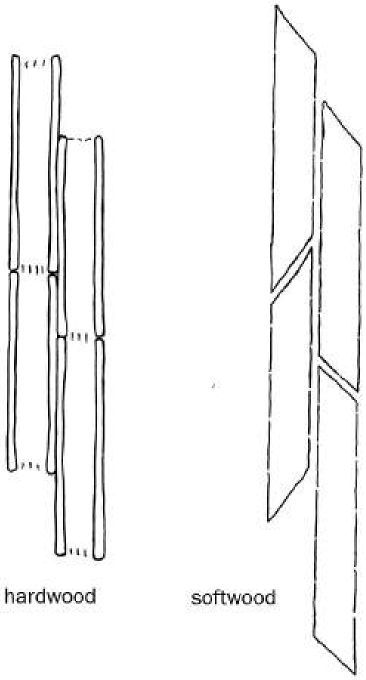


fig 3 : hardwood and softwood cell structure

initial growth

Imagine a year old tree sapling about six inches high. It has a core and as yet no annual ring. In year two the initial growth is quick-growing spring

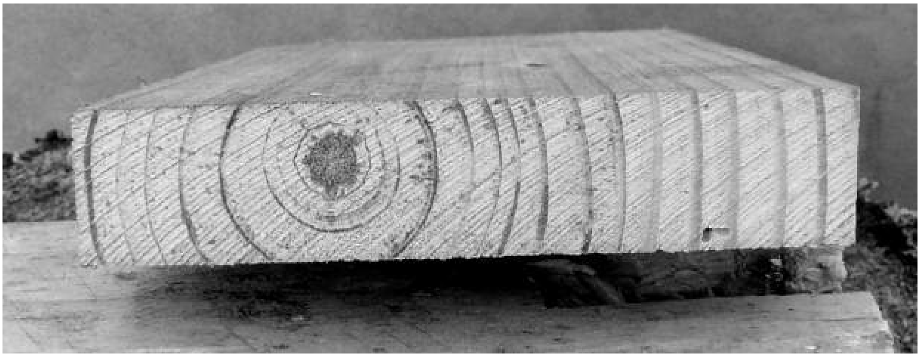


fig 4: early growth annual rings seen on the end of a softwood board

wood. This grows on the outside of the sapling from the last year, and then as the year progresses the summerwood grows on the outside of the springwood. Logical enough. This means that standing trees are made up of a series of stacked and interlocked, very steep, angled wooden cones. This initial core being (say) six inches high, then the next year's growth going to fourteen inches, and the next year to two feet.

Each year's growth is stacked on top and outside of the previous growth. This process not only produces timber volume, but also creates grain. How this affects the use, working properties and stability of the timber will be covered later because I have to build this information in a logical way for it to make sense.

fig 5: a two year old oak, with a side branch developing

annual rings

A cross section of most trees will reveal a series of concentric, light and dark coloured rings. These are the annual growth rings and there is one of each for each year. I think at this point we need to clarify how a tree grows. It has already been made clear that trees grow from the top upwards, and that they grow from the outside further out. That's the series of cones one over the other I mentioned earlier, and so you can now see how this makes up the annual rings. So there are several parts to this growth, as the tree comes out of dormancy for a deciduous tree, or semi dormancy for an evergreen tree, there is a period of quick growth which is produced just under the various layers of bark. This quick growth produces relatively large cells with cell walls that are thinner than the later growth. It results in the light coloured growth ring and is called springwood.

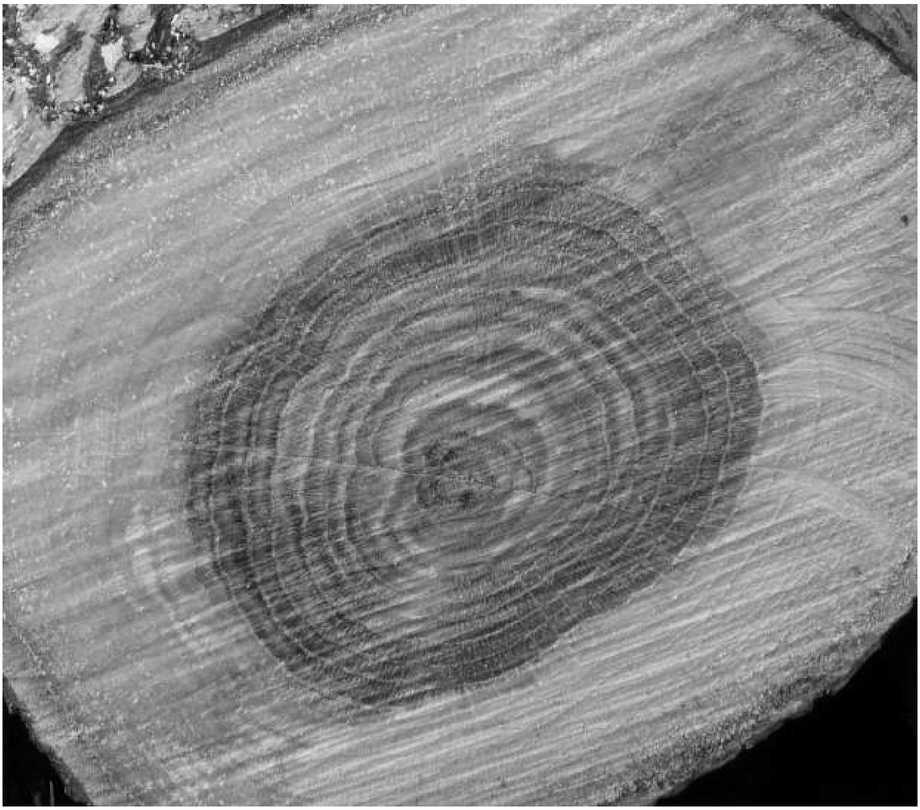


fig 6: end of oak log

As the year progresses the priority of the allocation of photosynthate is changed to favour production of flowers and seeds, so the growth in the physical structure of the tree is reduced. This produces smaller cells that have a relatively thicker cell wall when compared to the springwood. This is called summerwood and produces the darker rings. So to come back to my earlier analogy of the series of steep-sided cones, these build up over the years and the growth is always on the outside just under the bark. This is why some trees show cracks in the bark, especially when the conditions are perfect for quick growth. The bark simply cannot expand enough to accommodate the extra diameter. If we look at fig 6, it shows the end section of a small oak log. As well as the annual rings there is also the dark centre and the light outer section.

This dark centre is the heartwood and, in those species that are durable, is the rot resistant part. So what makes it different to the outer, lighter part? Well, I have mentioned this earlier in passing when covering allocation of photosynthate. I'm referring here to respiration where the tree sustains itself by using energy to keep all the systems working and the cells happy. This uses up the sugars produced in photosynthesis and has some by-products that need to be got rid of, We know how we as a species do it and it can be quite messy, but trees store the by-products in those cells that are not actively engaged in the task of growth. As the tree gets larger the centre cells become redundant apart from providing structure, so the by-products are stored within these cells. It's like storing all your excess stuff in the loft or the box room. The advantage to us of this process is that these by-products can be quite unpalatable or toxic to bacteria and fungi and it is these little horrors that provide one of the constant and unremitting battles in the timber world. This, then, has the effect of making the heartwood of certain tree species resistant to rot, which is a good thing.

density

Many joiners and carpenters will assess the suitability of pieces of timber in different ways, but beyond defects, and they will be covered in their own section, is the width of the annual rings. The wider the rings, the quicker the growth and, for any given species, the less dense the timber will be.

In *the drying process* chapter we will be dealing with how timber moves as its moisture content changes, but the most important point here is that in general the closer the rings are together then the more stable the timber will be. Pine grown in Wales (relatively warm and wet) will have much wider rings than that grown in the Baltic regions where there is a shorter growing season and it is much colder in winter. We used to make staircases for a living as *Albion Stairworks* and in the early days before we set up our own drying kiln and because I live near a port, we used to buy Russian, unsorted redwood direct from the timber sheds in the port. The grading was somewhat strange as unsorted was better quality than firsts, which was better than seconds and thirds. All the timber then had marks on the ends of each piece, so the timber we looked for was marked E * * I. This last letter stood for the production area, and in this case Igarka and AR stood for Archangel, both areas in Siberia in the Barents Sea region. The double star denoted unsorted grade.

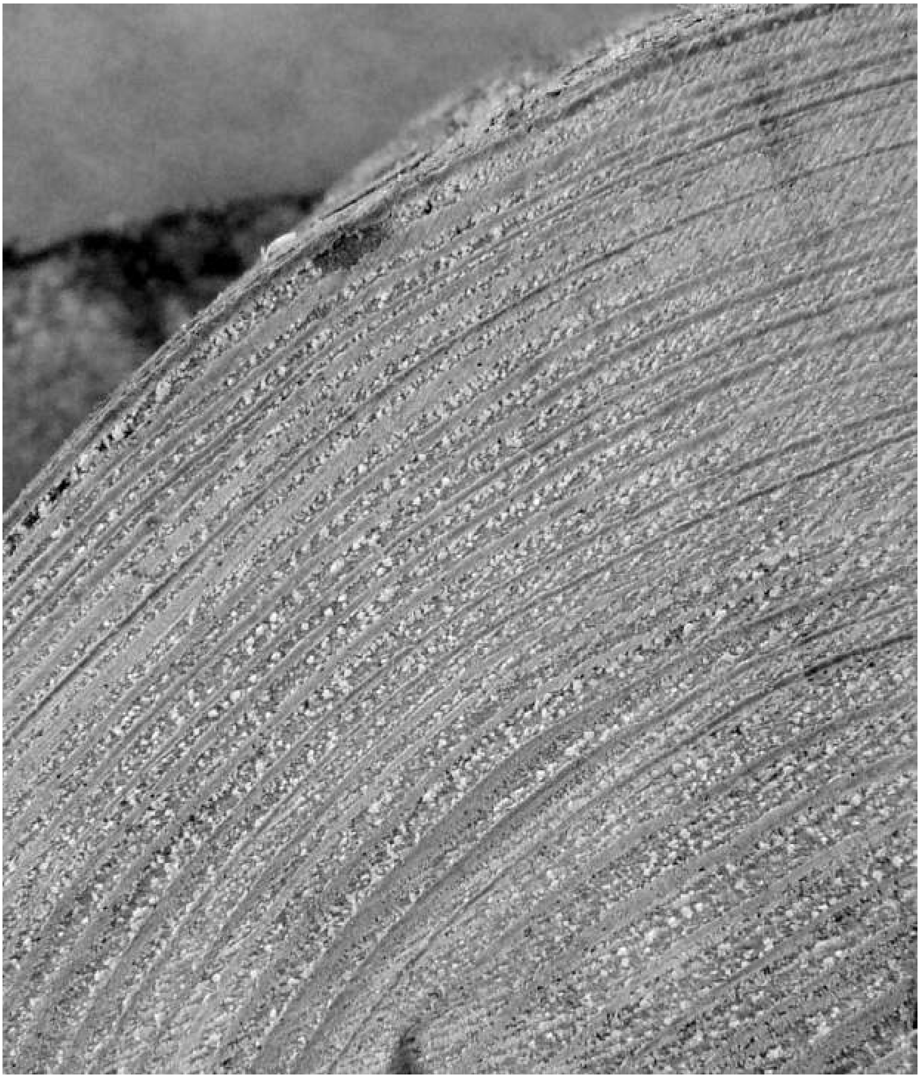


fig 7: narrow, slow-grown pine

In those days the Barents Sea was frozen for part of the year and so the new consignment of timber was only available in spring. The timber was dried to shipping-grade moisture content, at below twenty-five per cent, to prevent blue stain, see page 56, and so needed some further drying before use. The size we liked was 11 x 3 inches, which was then cut down the middle to 11 x 1¼. These 11 inch boards were fine for straight stairs, but when building winding stairs with all the associated built up strings and winders then wider boards would have been better. Wider boards were not so readily available and of course more expensive, so this was a further driver for developments in our in-house timber processing.

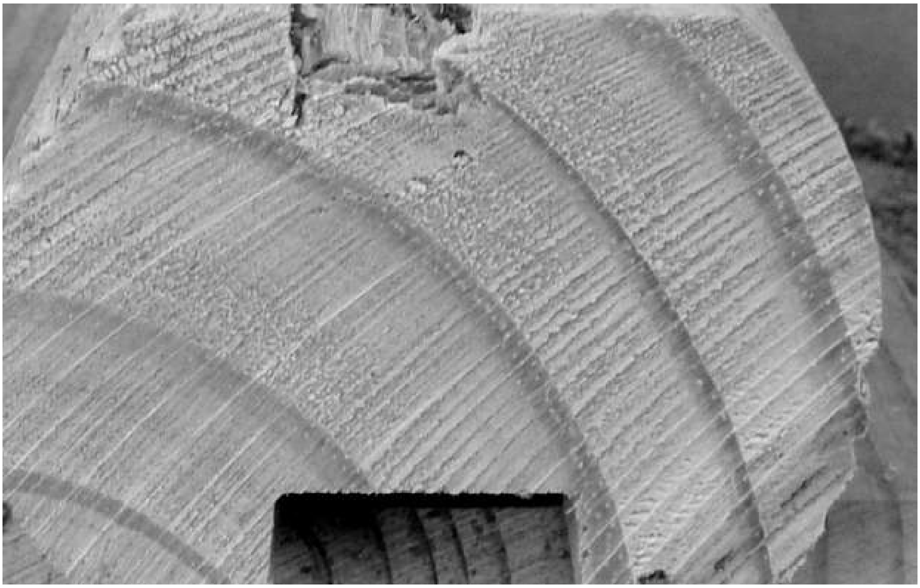


fig 8: wide quick-grown pine

Even at this stage in the business it seemed not quite right to be importing packs of timber, although this has been going on for centuries. In fact the cottage we live in was built in 1844 and the upstairs floor joists were certainly imported timber as they are 4½ x 1½ inches planed and seventeen feet long as they go through the centre wall of the cottage all in one piece. You can imagine them probably being delivered by horse and dray from the port some nine miles away, and being planed meant that there was no need for the expense of a ceiling, just showing the underside of the floorboards and the joists with a coat of varnish.

So there are two types of timber in this world, home grown and imported and I think they should be treated in a similar way as your cash reserves; in that there are two types of cash, yours and everyone else's. The trick here, is to keep them separate.

branches and knots

Earlier I briefly discussed branches and the need to keep the lower ones small so they die off early. The idea being that there is a central core in the tree of maybe four to six inch diameter that contains all the traces of dead and pruned branches. Beyond and outside of that core the timber is clean and knot free. See fig 9, where the central core is on the left of the photo and the clear, knot-free growth beyond the core is shown on the right.

fig 9: central knot core

So why would we wish it to be so? Well, knots create faults in the timber and, depending on the use the timber is put to, these faults can cause problems, varying from structural weakness in joists, rafters, boards, or studs, or the knots will create twisting (winding) or bending as the timber dries. Imagine a floor joist of 6 x 2 inches with a 4 inch knot halfway along it – the joist will break easily at that point. Or maybe a 1 inch knot in timber destined for window casements – this will cause the timber to bend about itself and render the piece unusable. Even knots in fence rails can be a problem where horses or cattle rubbing on the fence can break them and then have an escape.

There are two types of knot, live and dead. Dead knots are generally smaller as the branch has died off – this is mostly caused by light competition as described earlier. These knots have dead bark surrounding them and so the fibres are not linked into the surrounding timber.

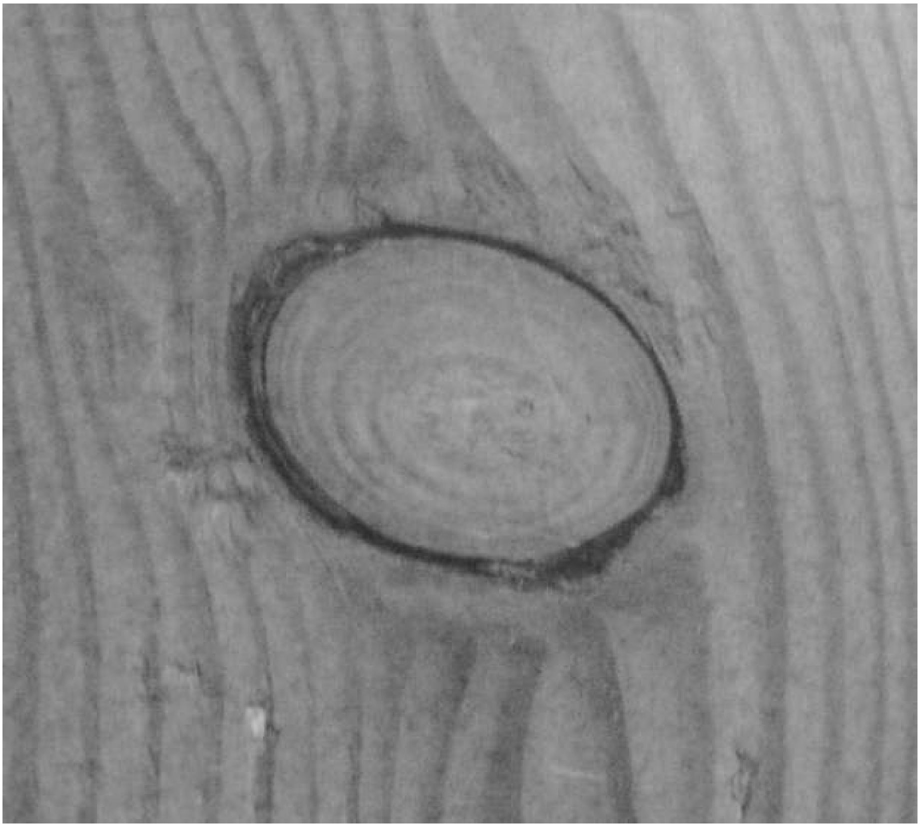


fig 10: dead knot in an old three-board door

Charles Sale goes on in some detail about dead knots in his admirable book *The Specialist* about Lem Putt, a champion privy builder. There's a mine of information from the door always facing east so you can sit there and bask in the early morning sun; to the door opening inwards so you can quickly kick it shut if there is an insensitive approach, the care and selection of boards for the door and a minor rant about the unsuitable shiny pages in some of the household catalogues. These door boards need to be devoid of dead knots, because if they don't fall out it's typical of human nature that they will get pushed out and it will be just at the right height to prevent you looking out but perfect for those curious specimens of carelessness to look in and spoil the tranquillity.

fig 11: live knot

In many trees the dead branches hang on for years and so the tree continues to grow round them, Douglas fir, larch, western hemlock, oak and sweet chestnut are particularly bad and to attain top quality timber these need to be pruned off early in the thicket and pole stage of tree development. This is where the tree crowns are extending upwards under the influence of the surrounding canopy, and the stems may be up to six inches in diameter.

Live knots are not so bad when they are small but the large ones still give structural weaknesses and introduce cracks and bending as the timber dries. The knot however is part of the surrounding timber and so is not surrounded by dead bark. Fig 11 shows a very dense live knot with at least fifteen rings. You can see here how the knot affects the timber around it and diverts the grain from an even straight grain to one that contains uneven tension on compression. This uneven grain creates problems with machining and planing the timber. The grain goes all ways so it is impossible to plane with the grain at all times. Cabinet makers use a thing called a cabinet scraper to finish off areas of opposing grain where a hand plane just lifts and opens up the grain.

branch collar

There is a correct place to remove a branch from a tree. This is the branch collar and can be seen as a swelling on the junction between the main stem and the branch. The collar should be left intact on the tree, but no

fig 12: grown over pruning cut

branch stub should be left. The branch collar contains specially adapted cells that are designed to create callus to heal over the pruning wound. If a branch stub is left then the tree will have to grow around the stub and there is an increased likelihood that a rot pocket will be created. When a branch is pruned at the correct place the wound heals over rapidly (two or three years). This can be seen in fig 12 which is a photo of a Norway spruce board.

The branch size should be as small as possible, but the specific size of branch that can safely be removed is dependent on the species and the timber quality. Oak will heal over after a six inch branch had been removed but with sycamore (for instance) the branch wound would start to rot before the callus had covered such a large pruning cut.

the grain

Just think back a few pages to where we were thinking of a growing tree as a series of very steep concentric cones stacked one on the next, the innermost being the shortest. Well, each successive layer of spring- and summerwood makes up the grain, and you can plane this one way to give a smooth finish but try and plane it the other way and you are trying to cut against all the open ends of the grain and it gives a rough finish. Imagine a ream of printer paper spread out in a fan. You can run your hand from the top page over the surface of the fan smoothly, but run your hand the other way and you are pushing against the ends of each successive sheet of paper. Sooner or later a sheet will catch and ruck up; it's just the same with the grain. See fig 13 that shows a board cut from a bent piece of log and so you can see the ends of the grain on the side of the board. The concentric rings show the outer rings on the right and so the timber was planed with the grain from right to left.

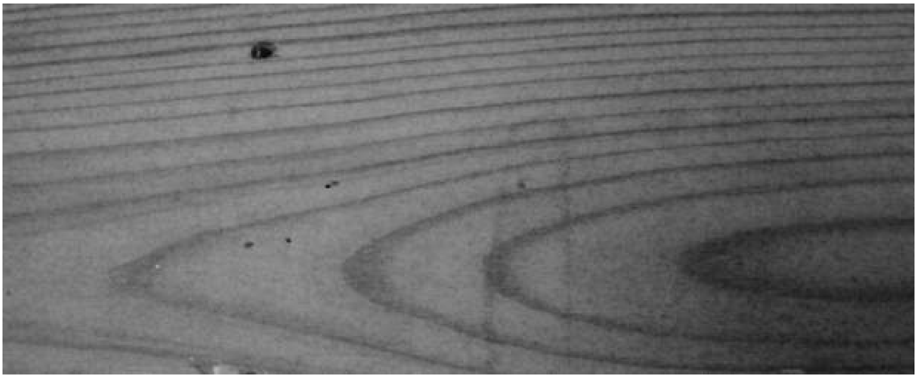


fig 13: grain running from right to left

felling trees

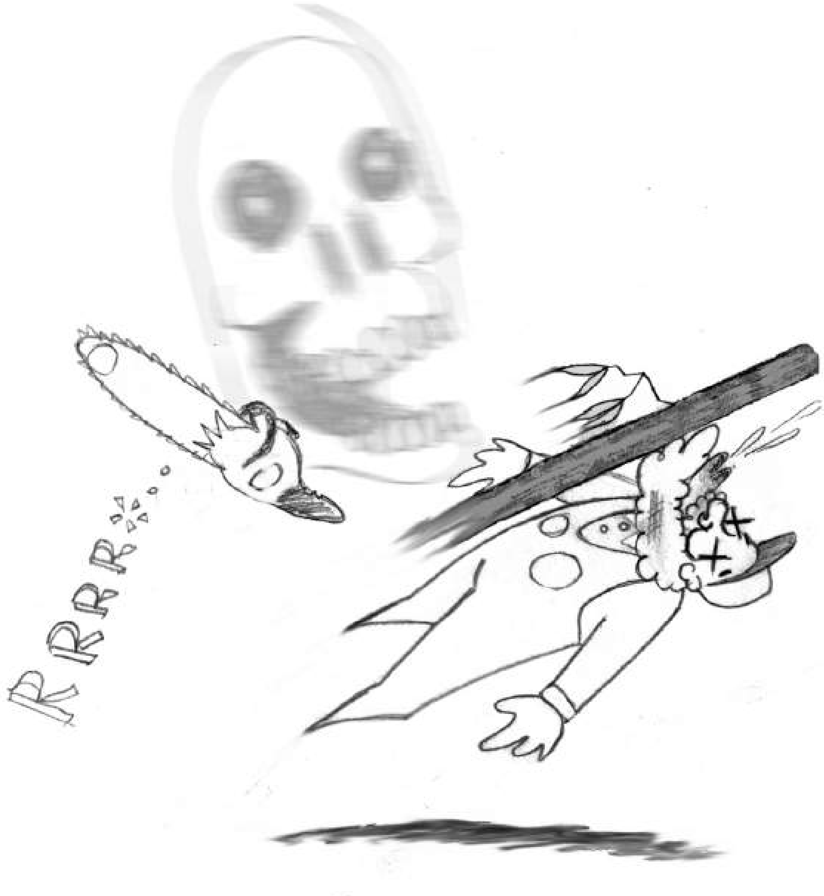
The traditional way of managing woodland in lowland Britain was through coppice with standards. This is a method of obtaining a wide variety of materials from woodland. The trees are cut at regular intervals depending on the products needed and the species. For instance hazel would be cut at seven-year intervals, whereas ash may be cut after twenty years depending on the size of timber required. That is the coppice side of the system and the standards are trees that are left uncut for maybe a hundred years to produce saw logs, beams, and structural material. The spacing of these standards is important to allow plenty of light onto the woodland floor and the growing coppice to prevent suppression. In this way the natural regeneration of correctly cut tree stumps was used to provide the next crop of products. The regrown stumps are called stools, but not all trees behave in this way. Most conifers do not have this property, except coast redwood, and some hardwoods are better at it than others. Cutting the stumps very close to the ground to a forestry standard is not helpful if regrowth is required. Stumps are cut low in many cases for several reasons; the most important is that high stumps are an impediment to timber extraction as logs can get caught up, the passage of machinery blocked and tyres damaged. However the felling and extraction of timber is a difficult process and the methods used depends on the size of the timber, the end use, the site and the species. This could be a whole book on its own, but this short chapter is included as a general overview of the subject and as a warning that it is dangerous, hugely time-consuming and best left to the professionals.

When we were making staircases we kiln dried fresh-sawn, home-grown timber for our own stock. I always inspected logs at a mill so that the felling and extraction was already done and I could inspect each log and only take the ones that were suitable. I have however taken part many times in felling operations and been six inches away from death or serious injury on several occasions.

We were felling beech in the Chilterns not far from High Wycombe. They were a reasonable size, up to something like twenty-four metres high, so it was what is called a selective fell (removing more trees than a thinning) and was part of a programme to promote natural regeneration from seed. The canopy of beech woods is dense, so dense in fact that the majority of the ground cover is shaded out. It makes life easy for felling and surveying operations, as you don’t have to struggle through the brambles.

That reminds me, I was marking a block of Scots pine up at Skellingthorpe quite a few years ago. It had previously been well thinned and enough light had got in for the brambles to get away. Anyway it was ready for the next thinning but the brambles were still about five feet high. I had a battle to get the ten acre block marked, and when the felling gang started they soon learnt to just follow my bramble beaten tracks, and lo and behold they led to marked trees; who would have thought it?

Let's get back to High Wycombe. The selective fell was progressing and a large John Deere skidder had arrived on site so we could get some of the timber out. The trees were to be extracted 'whole pole' meaning that the trunks were not cross cut on site and the buyer would normally transport the timber in as long a length as possible. This gives greater flexibility in the sawmill so that differing lengths can be cut prior to milling depending on the orders at the time and reduces wastage. One of my near death experiences was on this site. Mid afternoon I was felling a tall, straight stem, I'm guessing total weight about five tons. All went well with the felling cut and the wedges were in the back cut to encourage some movement in this well-balanced tree. Off she went and off I went down an escape route. So if the tree was falling to six on a clock face, my escape route was towards the number two. I'd gone about twenty yards from the stump and turned round as the tree was breaking through the canopy of the surrounding trees. When felling you always direct the tree to a gap in the canopy whenever possible, sometimes the weight or lean of the tree does not make this possible. The thing to avoid is getting the felled tree hung up in the surrounding canopy, that's dangerous and time consuming. So I had turned to see how things were progressing, chainsaw in my left hand, and I assumed sufficiently far away to be out of any immediate danger. When without warning it was as if someone had just grabbed the saw out of my hand. I didn't feel anything, no shock or noise, but looking down I saw a branch had broken off the canopy as the felled tree forced its way though. The branch had sprung back and flown over to knock the saw out of my hand. This demon was about 10 feet long and six inches thick. Had I stood three inches further to my left then you would not be reading this. Ho hum, and those of you who are paying attention will notice it was on my left side. Death sits to your left and observes until it chooses to tap your shoulder; not this time.



some basics

So felling trees is dangerous and using a chainsaw makes it more so, as the chainsaw in itself is inherently dangerous especially to the uninitiated and untrained. There is the first thing, always get good certificated training so you have an idea what you are doing and in the UK you need to have some proof you have followed the HSE guidance (Health and Safely Executive). There is so much difference in usability between a sharp and a not-quite-so-sharp chain, and a blunt chain that should never have got to that state in the first place if you knew what you were doing. Some people think that sending a chain off to be sharpened once a month is good enough, but a professional saw user will attend to chain sharpness every tank fill or more

fig 14: beech woods

frequently if the chain hits anything that will dull the cutter edge. Nails, especially where the older style gamekeepers are concerned, sand, soil, wire, flints, anything like that will take the edge off and the saw will not cut well or even straight. So again good quality training in saw maintenance and chain sharpening is vital to provide efficient use of fuels, oils, time, and reduce the polluting effects of running a saw.

My mate Jon tells a story of when he was a professional cutter on thinning conifer plantations. Cutters were paid either on a tonnage rate or a price per piece cut. The story goes that he was producing more produce and using less fuel and chain oil in the same time than the other members of the crew. This was down to touching up the chain with the correct file every tank fill, making sure all filters were clean to give efficient running, ergonomic use of the saw and only revving the saw when cutting so the saw had to run sweetly and tick over reliably.

I used to teach quite a few chainsaw courses (cannot be doing with it now) and it was surprising the state of some of the saws that were sent with trainees. The Arb companies were the worst and because day one was maintenance, then the saws were given a good going over. Next day these dubious saws would not run right because they had been set up to run as best with bad spark plugs, partially blocked filters, bad oil pumps, and worn out sprockets and clutches. Not a good example for an industry that supposedly prides itself on shiny kit and professionalism.

I think you have already guessed that I would not suggest using a chainsaw without training and supervision and working alone with one is right out, unless you are qualified, experienced and apply the working alone guidance. So let us imagine that what follows is guidance to assess the suitability of any contractor you may be using.

Unless for some very-site specific reasons then the felling height is either just above ground level or if the management regime is to promote coppice regrowth then about six inches above ground level. By ground level I mean the highest point, so if the trees are growing on a slope or a bank then the felling height is determined from a datum on the uphill side. This has an effect on the sink cut as described in a moment. I have been managing a coppice site recently over in Nottinghamshire where the six-inch stump rule was in the contract. The product was firewood from this neglected woodland area. However the employees of the contractor were being lazy and doing the usual aboricultural thing of felling at a height that is easy. The thing was that, one of these employees had been assessed by me for chainsaw competence not six months before, so I knew he was capable of doing it right. Words were had in no uncertain terms, as it is important to keep the standard to get good healthy growth from the stools.

the sink cut

So the sink cut is comprised of a series of initial cuts that determine which way the tree will fall as long as the other cuts are up to standard. If you imagine a slice of melon, that is the shape of the piece you wish to see removed. If this were a one-eighth segment of the melon then the angle between the cut faces would be forty-five degrees. Simple enough so far, however this segment should not extend beyond a quarter of the tree diameter.

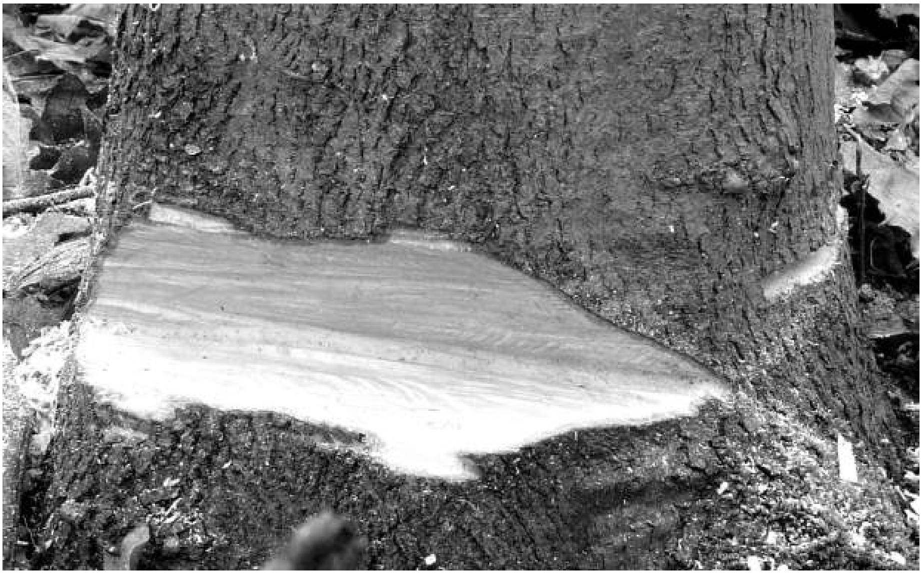


fig 15: sink cut

Think about it this way; to get good directional felling the trees must have a hinge to control the direction as it falls. The sink cut has two functions, to allow space for the tree to start moving and to create the front face of the hinge. Cutting a large sink is inefficient as there is more timber to cut and it also means that the tree will be very unstable during the creation of the back felling cut. This back felling cut on a tree up to fifteen inches in diameter is between level with the bottom of the sink and one inch above and should stop when the saw chain is one inch away from the inner corner of the sink.

It is important for the series of cuts to be in the right order and to start in the right plane and at the correct height. The first cut is the sloping cut at forty-five degrees as part of the sink. This is where it starts to go wrong as many lazy or untrained people start too high and so end up half way through the tree. If you can sit the saw next to the tree with the bar vertical along its

fig 16: felling cut

narrow side, then by marking where the top of the bar is, this gives a guide as to where to start the cut. Why should it be forty-five degrees? Well, the second cut is the horizontal cut, and it is important for the bar to be level both along it length and across the width. Many people use a saw with the nose of the bar pointing slightly down and so the cuts are not level and this upsets the whole geometry of the cut. It's not the nose or left hand too low, but the right trigger hand too high. If you see this sloppy nose down use of the saw then dismiss the operator, because it shows a lack of interest and understanding.

What happens is that the sink cut slopes away from the operator and then the felling cut slopes away also, but of course the operator is standing on the opposite side of the tree to create the felling cut. This compounds the crime. Why does the operator stand on the other side of the tree? Well, it's because you try to use the bottom of the bar as much as possible for all cuts. Why? That's because the bottom of the bar is using a pulling chain where the rotation of the chain pulls the body of the saw up to the tree. On the top of the bar the cutters are facing forwards and so the action of cutting will try to push the saw away from the tree, an action that needs to be resisted by the operator.

Whilst we are talking about bars and saw chain cutters, there is an area of the bar called the kick back zone. This is the top quadrant of the bar nose, where the forward facing cutters are starting to go round the bar nose.

There is a high tendency for the cutters at this point to try to cut too much timber. The reaction to this is for the cutters to stop and the bar and saw to be flung backwards towards the operator. The speed and violence of this depends on the type of chain and the length of bar. The bigger the cutters and the longer the bar the greater the hazard and believe me it is violent enough, in some extreme cases, to break your wrist. Only professionals use this section of the bar and then only if there is no alternative and with extreme care.

fig 17: bar as a guide

So the sink cut is created using a pulling chain and with the tree at your left shoulder. Once the sink cut is completed and you are happy with the direction of fall, then the felling cut is started at the back of the tree, again with a pulling chain and the tree at your left shoulder. You would be standing on the other side of the tree and in line with where the hinge will be. As previously described this felling cut should be horizontal in both directions and be between level with the bottom of the sink and up to an inch above (and no more). Why no more? The felling cut should stop one inch away from the inner corner of the sink cut so that complete and intact wood fibres make up the hinge. If you cut too high then there is a tendency to cut too far forward and the strength of the hinge is lost or the fibres are incomplete and do not connect the stump and the tree together correctly; meaning a loss of directional stability and a potential for some severe personal crush injuries.

fig 18: beech felling

Let me make it clear here that the operator does not keep cutting until the tree starts to fall but stops to create the correct hinge dimensions. If you cannot see round to the other side of the tree then put the chain brake on and leave the saw ticking over in the cut, go and have a look. If the saw will not tick over then you should not be using it. It's the same with the felling cut height, just make a mark with the saw at the height you judge to be right, and then stand back two or three metres. It is then obvious if it is right or not.

fig 19: beech felled

This brings to mind assessing some chainsaw candidates a while back, nerves are a problem in many cases until the candidates get into the swing of things. One lad was confident and showed good use of the saw and underpinning knowledge but his felling height was too high on his first tree. A discussion about determining the felling height made him aware that standing back and checking before you commit is fine and acceptable. No problems from that point on, nerves and wanting to get the assessment over and done with had had an initial detrimental effect.

So the answer to the question posed earlier about the sink cut angle is – as the trees falls the sink closes and then the hinge is snapped by the momentum of the fall before the tree hits the ground. This prevents the tree from splitting as it hits the ground with the hinge intact and can be seen in fig 18 where the hinge fibres are just being pulled apart as the sink cut closes up.

keeping yourself out of jail and hospital

leaning trees

If the tree starts to fall whilst the operator is still cutting, this means several things. The hinge could be too small or has been severed, or is a wedge shape and too thin or non-existent on the far side of the tree. Or the wrong cut has been used. For trees leaning forwards or backwards to the direction of fall there are specific cuts for each of these situations. In a leaning back situation the effect of using a standard felling cut is that the tree sits back closing the felling cut and traps the bar. To prevent this either select another felling direction or use the split level cut that an operator will have been trained to use. For a tree leaning in the direction of fall things are more serious and dangerous. The tree wants to go as soon as it can because the weight of the stem and crown are only retained by the back of the tree; in many cases with a leaning tree the heart is not in the centre and the stem is made up of reaction wood, with wide-ringed tension wood at the back and narrow ringed compression wood at the front. This can be seen in fig 20 showing a section through a larch log. As we will see later, this gives problems with saw milling and drying and reduces the value of the log.

fig 20: off centre heartwood

So what happens if a standard felling cut is used on a leaning tree? And some trees lean so much that there is no choice of felling direction. Well, before the felling cut is complete the back half of the tree starts to move but the front half resists. The upshot of this bad practice is the tree splits down the middle with the back of the tree flying backwards pivoted from a point about twelve feet up the tree. This does one of several things, makes you grow wings or wheels. Meaning you could be in a wheelchair for the rest of you life, or grow wings and have half a day out with the undertaker, as Fred Dibner would say. The tree does not split with any warning, it happens in milliseconds and you have no reaction time. It's almost like a medieval siege machine with unforgiving violence and speed.

We were on a felling site towards the top of the county some years ago. There was a youngish lad felling with us. One late morning he came walking over past me from his felling area. He was as white as a sheet and all he said was: 'I need some time out, could you sort that mess out over there?' Off he went in a hurry, so I wandered over with my saw to have a look. He had attempted to fell a leaning ash of about 18 inch diameter with a standard cut, and ash is one of the worst for splitting like this. The tree was split to about ten feet and the rest of the tree was sat on the top with the crown one side and the remainder of the split stem horizontal at the other side, like a big letter T.

Sorting this out is covered in the multiple wind blow course as part of wind snap. The way to make it safe is to reduce the crown that is partially resting on the ground, so as to make it more stable and then after standing back to judge were the majority of the weight lies, felling the remainder sideways with an appropriate cut. In conversation at lunch time the lad said that the saw flew out of his hand, and it was as if a big hand shoved him sideways so that he landed on his back some ten feet away. Again the tree would have been to his left.

So to return to felling trees correctly, the sink cut is at forty-five degrees, the felling cut is level and no more than an inch above the bottom of the sink and the hinge is at least an inch wide and parallel. Having judged the trees correctly for the type of cut, the tree will then need some encouragement to fall. Do this with a felling lever or a plastic or aluminium felling wedge. If there is some minor imbalance in the crown the tree may well go without help. The trick here is to know it is going and step smartly away down your escape route as it moves, not after it has hit the ground; attention is important here. You don't just stand at the back of the tree and watch it fall, unless of course you wish for some broken bones and a severe loss of teeth.

hung up trees

These are what it says, and they are hung up in the crown of another tree, and the felled tree has not had sufficient space or momentum to find it's way through the surrounding canopy. This is dangerous in that the tree may fall at any time. Let's give you an example this time that does not include any death defying sets of circumstances. It is common in thinnings to get trees badly hung up. Conifers, due to the shape of their crowns, get hung up but are commonly much easier to dislodge than hardwoods. Neglected broadleaf woodlands are the worst as the crowns are often distorted, produced as a consequence of the intense competition for space and light in unthinned areas. When working in such woodlands each operator has their own area and it is common at break times for someone to say: 'hung up tree over there, so watch out'. On still days cracks and groans emitted by these crowns can be heard as they settle and the outer small branches eventually give up the struggle and break. More often than not a few hours later this hung up tree will come tumbling down with only the minimum of notice. This could be when you are using a chainsaw close by or a member of the public is wandering aimlessly along a woodland public footpath.

So there are several rules about these trees:

- don't fell the tree it is hung up in
- don't work under it
- don't cut sections off the bottom
- don't climb it in an attempt to dislodge it
- don't stand immediately behind it
- don't leave it without cordoning it off and informing the landowner

There are others, but that's enough for our purposes. To make these safe a winch or a forestry machine is required to pull them down.

medium and large trees

These are trees with a diameter over fifteen inches and thirty inches respectively. Specialist techniques are required for this work, as well as confidence with the saw, proficiency in producing smooth flat cuts and the ability to sharpen the chain to a high degree of accuracy. There are courses and certification covering this work and all require candidates to hold chainsaw maintenance, crosscutting and felling small trees qualifications as a prerequisite.

organisation prior to felling trees

This is all of the general organisation that gets done sometimes without any undue fuss or, in the worst case, not at all. In the UK responsibilities come with felling trees in the form of the Wildlife and Countryside Act, tree preservation orders and the need for a felling licence in woodlands.

The Wildlife and Countryside Act makes it illegal to interfere wilfully or accidentally with protected species and habitat. This means (and is not limited to) birds, badgers, bats, newts, raptors etc. You do not fell any trees on or on to a badger set. Old gnarly and ivy-covered trees may well be bat roosts so it's best to leave these as veteran trees. A check on the National Biodiversity Network website will identify recorded species and when they were recorded on any site in the UK. This is particularly useful when concerned with bats.

A tree preservation order (TPO) is placed on a tree by the local tree officer. Areas of trees, usually in villages, have a similar protection within a conservation area. There is a large fine for felling any such tree and it is up to the operator to check with the local council. Don't trust to someone just saying 'I'm sure there isn't a TPO on it'.

A felling licence is required in woodlands where more than three cubic metres of timber for sale is cut in any calendar quarter. The limit is five cubic metres if the timber is not for sale. A felling licence is not required in gardens or orchards, but in this case it would be advisable to check for a TPO. Felling licence applications are sent to the area Forestry Commission Grants and Licences Office. The form is downloadable from the Forestry Commission website (see *resources*, page 169).

A contract is required between the landowner and the felling contractor. This is just to protect both parties, as in many negotiations assumptions can be made that turn out incorrect. Best get in writing such things as start and finish date, price paid, area marked, extraction methods, payment method, post-felling site condition. Not having a contract can leave you open to unreasonable demands, so have a contract and stick to it.

risk assessment

Let's assume you have never been to a specific site before, and today you are there with your workmates to fell the marked trees. The first thing is to walk the site because you never know what is on the far side of the woods. So have a good wander about looking for things that may cause a problem. Footpaths, overhead power cables, roads, steep banks, areas of hung-up or windblown trees, badger sets, streams, 200 foot quarry edges without a fence, firing ranges.

If you find anything that could cause a problem then write it down and include a control measure so that operators are not put in danger.

A selection of control measure examples follow:
- power lines: an exclusion zone equal to two tree heights in width, so there is no possible way that any felled tree can contact the power lines
- footpaths: use signs and barrier tape when felling within a two tree length distance; for a heavily trafficked footpath have a team member act as a banksman to stop the public
- dangerous areas: put up signs and mark where possible (lines on trees or use barrier tape)
- badger sets: don't fell trees on or on to the area
- streams: don't fell trees into the watercourse and keep fuel and oil well away

So once that is completed you need a quick checklist of where you are. This is needed so that in an emergency you don't have to remember the site details when contacting the emergency services, it's all written down and you can just read it out. This would include:
- location name
- OS grid reference
- access point and type of access (if 4x4 vehicle is required)
- nearest helicopter landing point
- nearest road junction where a team member could meet the emergency services

Once this is all written down then all the team members should see it and sign it and hopefully if it is applied then you won't need the checklist.

site organisation

If you were the foreman, or team leader in modern, human resource psycho-speak, then this is short list of important considerations:
- all operators should hold the correct certificates of competence for the task required
- all should wear the correct personal protective equipment (PPE); this means chainsaw boots, trousers and gloves, and a forestry helmet with visor and ear protection
- a central fuelling point is required for communication and refuelling; this should be on level ground, out of direct sunlight in summer, at least thirty metres away from a water course and with a spill kit or similar, and a first aid kit

- all operators should work at least two tree lengths apart from each other and keep in communication frequently

The felling should stop if weather conditions change so that the control of felling direction is lost, or the weather is so severe in other ways that it makes further work dangerous

liabilities and insurance

Let what follows be taken as general guidance because these issues change frequently as they are concerned with legislation, insurance companies and the HSE. The guidance is split into two issues, namely training and insurance cover.

You need proof of training when using a chainsaw on any land other than your own but if you use a chainsaw untrained on your own land and there is a liability issue, then I suspect you are on your own in the big, bad world of money talks, liability claims by a third party, or litigation under the Wildlife and Countryside Act or the felling licence legislation.

If you are employed or work in anyway on land other than your own then training and certification is definitely required.

In addition to that it is a complete waste of time to use a badly maintained chainsaw and also have the exacerbated risk of a hospital visit or half a day out with the undertaker.

logs and round wood

I've already mentioned that in my previous business activities I bought my timber fresh sawn from a sawmill, and it was only in later years that I used my own sawmill at home for timber conversion. At that time the decision was based on the logistics of volume of timber required, size of logs, time and quality. I required fourteen foot logs of good quality and of a large size to get twelve-inch boards out of them. So as it happened I would frequently go past the Linnell sawmill in the village Silverstone in Northamptonshire (where the race track is). This was before the bypass was built, the mill has all gone now, and I suspect it has grown houses. This mill was run by a set of brothers; Edmund and Brian are the ones I remember.

I would be delivering stairs down that way frequently and so when I needed more timber I would phone up a few days before the trip and place an order. On the way past I would call in to inspect the logs that Edmund would have laid out for me; he always kept a few of the best for me because I would order about six times a year. We mainly used poplar as it was readily available, a decent price, of large size and was fine if left in log form in the yard for a few months before being used. Poplar is one of those woods that seems to retain its sap for quite a while when in the round; meaning the complete log not split or converted in any way, just as it came from the tree. Having selected the logs, or parts of logs I would continue on and on the return later that day I would collect the sawn timber. Just a note here – you don't have to accept all the stack if some boards have faults, like having the heart in them (otherwise know as pith, being the first years growth in the centre of the tree), or shakes, bad knots, and areas of rot, just reject them. We will cover all of these faults from page 52.

The point being here that I bought fresh sawn this way for many reasons. They are:

- the use of home-grown timber
- the poplar logs would weigh at least two tons so I would not be able manoeuvre them at home
- I did not have machinery large enough to mill that length of timber
- I used about 500 cubic feet of sawn boards each year so this was not enough to consider investing in a much larger saw
- because I rejected unsuitable boards there was little waste, so I used what I paid for
- this goes along with the basic premise that keeping the overheads

down helps build a successful business
- this set-up was time and fuel efficient for that volume of timber as there was no extra mileage and time for collection

fig 21: mill yard log stack

In this case it was sensible to buy fresh sawn timber because the choice was about volume, weight, size and commercial expediency, but in many other cases it is far better to mill your own and take your time, for instance if you are repairing buildings, making doors or window frames or building a new wooden shed. So there are many factors that will affect this decision making process some of which will be concerned with 'I want it now', to which all I can say is, chill and take the long view, enjoy the process and don't only think to the end result.

So a log on the ground is the starting point, and hopefully all the branches are cut off flush with the stem so it is less likely to snag on everything. The first question is, 'is this log suitable for my purposes and of the right species?' Then this is followed by 'can I get my mobile saw to it, or how can I get this to my sawmill?' It is yet again one of those multi-question, multi answer situations, so let's start somewhere.

species

A degree of flexibility is required here because of local availability. I have had the situation in the past where a designer has stipulated a specific timber for stairs, and I've known there is a good chance the choice is only because the name sounds impressive, and there is no consideration to availability, cost, size available and the environmental impact of transporting it.

So, if you want softwood for the frame of a timber building then anything goes:
Scots, Corsican, lodgepole, Austrian, Monterey pines, Norway and Sitka spruce, western red cedar, larch, and all the types of cypress, grand fir, and more.

If you then need a durable timber for the external cladding then hardwoods or softwoods would be suitable:
Western red cedar, western hemlock, oak, sweet chestnut, Scots pine, lodgepole pine, leyland, Monterey, or Lawsons cypress, larch, redwood, etc.

Some are, of course, more suited to the intended use than others, for instance the hardwoods in the cladding list are more liable to warping as they dry than the red cedar or Scots pine. Remember here that it is the heartwood that is durable and the sapwood will rot away quite quickly. Sapwood will be covered in detail later but just for now it is the live outside portion of the tree and is commonly a lighter colour. This is very evident with oak and sweet chestnut where the sapwood rots to a mushy mess within three years given the right circumstances (like in a stack of logs in the weather).

quality and size

So let's assume some of the timber available is of a suitable species, the next assessment is of its quality and size. It takes more effort to cut a 4 x 4 inch post out of a 6 inch log than four such pieces out of a 12 inch log because there are less passes of the saw and turnings of the log. There are four passes for a single 4 x 4 and six passes through the saw for four pieces of the same size. So size of timber is relevant up to the point where moving it becomes a problem as seen in the poplar example at the beginning of the chapter.

defects

This is a huge and diverse subject so perhaps a list will help:

- shake
- live and dead knots
- rot
- fungal stain
- spiral grain
- large knots
- damage scars
- tension and compression wood
- included bark
- branch bark ridge.
- log taper and bend
- frequency of knots
- epicormic growth
- bark rose

When you are inspecting the log remember that it's only the outside you can see, so there is some imagination required to try to look into the tree's history from the evidence given by the marks in the bark and the butt end. You also have to keep in mind the underside, where an unscrupulous seller may place a log with a major defect hidden because it is against the ground.

shake

This is seen as either star shake or ring shake and is shown as splits or cracks in the timber starting from the butt. Not all species suffer from this, but oak and sweet chestnut are both known for this fault. The buying of these species standing (unfelled) is fraught with financial difficulties unless an understanding on shake is put in place in the contract.

star shake

This is a series of radial cracks that start at the heart and commonly allows rot to take hold. Figure 22 shows both types in an oak butt, and here the staining around the shake would have developed after the tree has been felled. Initially on felling this shake may well not have been noticeable to the novice, but after a short time the signs become evident. As rot finds its way into the shake in a growing tree then on felling the shake is immediately obvious and the rot will have had an effect further up the tree. If this example were milled the boards would just fall apart or have major structural defects.

fig 22: star and ring shake

ring shake

This is more common in sweet chestnut and is a split around part or all of the annual ring. It has the same basic effect as star shake, but because it is circular it gives a clue to the cause of this defect. It will affect the sawn timber in the same way as star shake.

the cause of shake

Later in this book we will cover the drying of timber, moisture gradients and problems caused by various drying regimes. The cause of shake is closely linked with this subject and the growing strategy of all trees.

As timber dries it shrinks and this movement is mostly across the grain rather than along it. When you add this to the fact that springwood cells, as previously discussed (see page 22) are larger and have a thinner cell wall than summerwood cells and so are weaker. This springwood growth creates an area of weakness within the structure when the wood is dried. Trees use water as part of the process of photosynthesis and lose water though their leaves as part of the respiration process. This water has to be replaced by water drawn up from the roots and makes its way to the leaves through the cells that make up the sapwood. You see it's all starting to link together.

Now in a particularly dry summer in trees with large crown there is a huge suction in the main stem as all the leaves draw on the moisture supply. OK so there are valves in the leaf called stomata that can close to reduce water loss where there is a moisture deficit, but only up to a certain point. So now take the fact that the heartwood of a tree is made up of dead cells that are full of water and by-products of respiration. On thin or sandy soils the water may not be available in sufficient quantities, so the tree draws moisture from its inactive heartwood. The upshot of this is that the heartwood begins to shrink, as we will see later, and there reaches a certain point where the live outside of the tree is effectively too large for the shrinking heartwood. Something has to go and the weakest point is the ring of large, comparatively weak springwood cells, hence ring shake is caused. Now sandy soils are mainly nutrient deficient, so in combination with the problems with moisture this means that trees grow relatively slowly and so the timber has close annual rings and is dense. In this situation where there are smaller springwood cells then there is a greater likelihood of star shake developing, or both as in the fig 22.

soil type

As soil type is a contributory factor in the development of shake I would just like to mention it briefly. So it seems that soils that are likely to produce a moisture deficit are thin or well drained. This could include alluvial sands and gravels or windblown sands that make up heathland sites or thin soils over a well-drained substrate. Sands and soils including deep clays in low-lying areas are more likely to grow timber without shakes. But waterlogged soils will have a detrimental effect on trees by limiting the rooting zone. I have known areas of mature oak that have died due to several very wet seasons when they are growing on sites that are at risk of being waterlogged.

We did some chainsaw training a few years ago for one of the wildlife trusts. The site was acid sand where a thick organic layer overlaid wet, low-lying sands and gravels. The compartment where the training took place was a thinning of naturally regenerated oak. The ten inch stumps revealed a very dense heartwood, with a very narrow sapwood (less than half an inch), and counting the rings gave an age over seventy years. Truly slow growing, with no signs of shake or rot because the crowns were small, the wet, low-lying soil prevented a moisture deficit and the stems were of a small diameter so the shrinkage would not be structurally significant. The organic matter layer is a good indicator of acid or alkaline soils; acid conditions will encourage this build up and on alkaline situations all the organic matter will be quickly decomposed.

At Revesby near Boston, in Lincolnshire, the majority of the woodland soils are heavy soil over chalk. In some woods the soil is quite thin, at a couple of feet thick, and one would imagine that oak shake would be common. Not at all as the underlying chalk acts like a sponge and keeps a steady supply of moisture. A notable example was a large windblown oak on soil less than a foot deep before the chalk was visible. This produced the perfect butt as seem in fig 23 with not the slightest sign of shake.

fig 23: oak butt from thin soil over chalk

live and dead knots

I've covered this subject in some depth earlier in the *growing trees, structure and knots* chapter, page 15, But just to recap:
Live knots affect the timber strength depending on the knot size and the timber use. They will also cause movement during drying and problems with grain direction and density change in the machining stage.

Dead knots are not attached to the surrounding timber as they are surrounded with dead bark. This gives structural weakness, and they can fall out of a board. See fig 24 where a dead knot extends all the way from the core to the outside of the log, as the tree has grown around the dead branch.

rot

This commonly starts from shake in the butt and then travels slowly up the heart of the tree. Bacteria start to break down the cell defences and this then allows fungal attack. Rot can also be introduced through damaged or badly pruned branches or mammalian attack. Grey squirrels strip bark

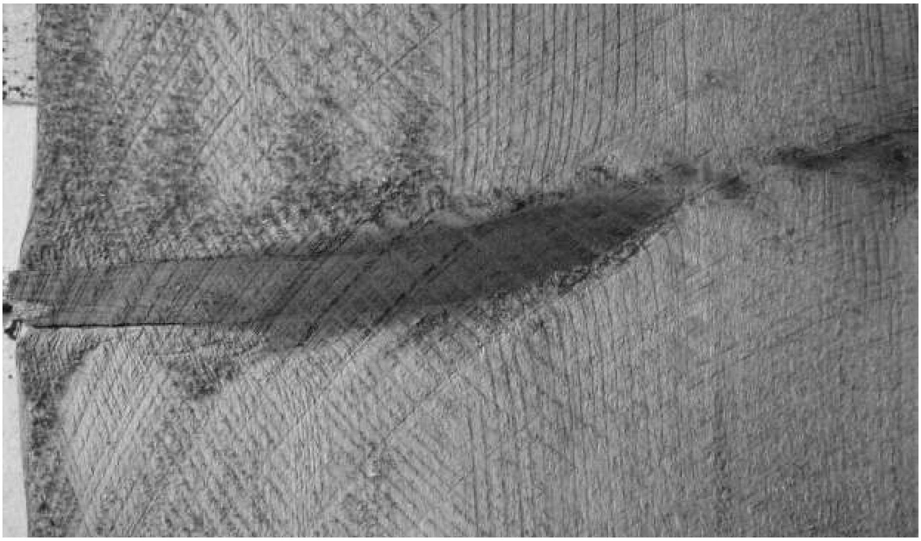


fig 24: included dead knot

from the crowns and the base of trees, particularly sycamore and beech, but they are not limited to these species. We are drifting here back into forestry, but the best thing to do with a grey squirrel is to eat it, as they do no good beyond nutrition. Fig 25 shows how rot has got into a broken branch stub even though the tree has eventually grown over the wound. The rot has then travelled into the heartwood of the main stem.

fungal stain

Fungus has breaking down timber as part of its natural process, it also stains the timber in the early stages of infection. This can result in brown oak, where the oak tree is infected with the beefsteak fungus which turns the heartwood a deep brown colour. When felling this type of oak the chainsaw chippings look like chocolate shavings around your boots.

Sycamore and beech can be infected with several species of fungus and this results in a feature called spalting. The various fungal types set up defences from each other within the timber. This defence can be seen as a black line with different colours either side.

In pines blue stain can cause degradation quite rapidly if the timber is felled in warm conditions. The timber of Scots pine can begin to turn blue from the ends of the logs within ten weeks or less. It does not affect the strength of the timber but degrades the timber visually.

fig 25: rot from branch damage

If it is not too dramatic (flecks of blue) then one can always make a feature out of it. For instance there is a species that was specially grown in a small area of the Welsh Marches where the microclimate is just right, from seed imported in the late 1860s from an unknown source in China by an enterprising and continuously aggravated plant hunter by the name of Arnold

fig 26: spalting in a sycamore shelf

‘Incandescent’ Mould. He named this species lake pine as it reminded him of the rare occurrences of sun glinting off a lake surface from the time he spent, as a boy, in Fermanagh.

There are other timbers that seem to gain secondary names, for instance Portuguese pine that turned out to be spruce and the occasionally-known west fen walnut of which we will hear later.

fig 27: blue stain fungus in a softwood log

spiral grain

This can be seen in the bark, most notably in largish sweet chestnut. You can see the bark lines showing a slow spiral round the tree. It shows up in sawn timber as it dries as a feature known to carpenters and joiners as winding (wind rhyming with mind). The board twists and here is the answer to one of my initial questions. Corsican pine commonly has spiral grain so this prevents the use of wide boards in this species. In the early days we used Corsican pine for stair newel posts and even 4 x 4 inch posts had some twist in them that had to be trued up on the surface planer, so one had to be careful not to plane too much off and loose the cross-sectional dimensions.

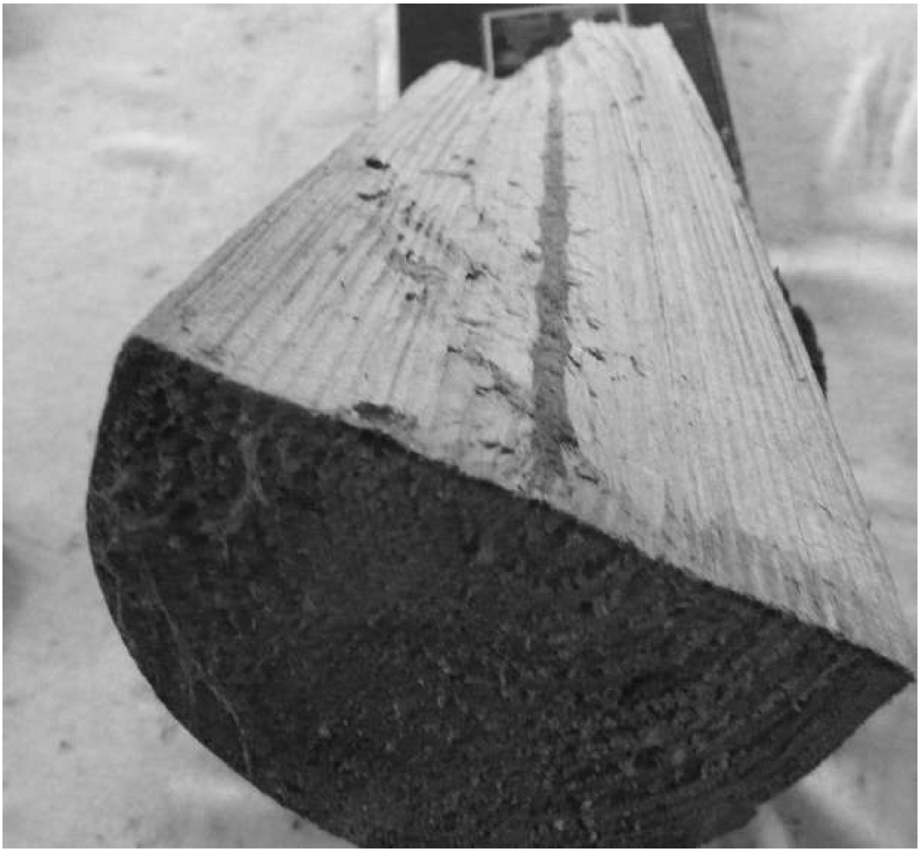


fig 28: spiral grain in a softwood log

large knots

We have covered this earlier, see page 16, but the basic premise is that the size of the knot should reflect the final use for the timber. So, an agricultural gatepost of oak with a 4 inch knot may be acceptable, because the knot has more of a visual impact than structural. If there's a knot that size in a 6 x 2 inch softwood floor joist it is clearly unacceptable and dangerous because it is a point of weakness. Fig 29 shows a log where a large branch has been removed after felling.

fig 29: oak log with large knot

damage scars

When felling occurs as part of a thinning there is always the risk of damage to the surrounding trees. This can be from the felled trees as they fall though the surrounding canopy or by extraction machinery removing bark from the base of the retained trees along the extraction route. The other cause is the squirrel damage spoken of earlier, and rabbits can cause similar damage in very cold winters although this is usually on smaller trees. If this damage heals before the rot gets in then there will be marks left where the grain is not connected, or 'included bark' caused by the healing process. In fig 25 you can see that the branch has started to rot even though the tree has grown over the end of the damaged branch. Fig 30 shows an area of grown-over damage within the elm boards of a tabletop. In this case it adds character to the otherwise somewhat featureless surface.

tension and compression wood

The reasons for this have been covered in the *leaning trees* section, see page 43, but the problems caused by it are only really apparent during the conversion process. If the conversion is by hewing with various axes into

fig 30: fault in elm board

beams and posts then, beyond movement in the drying process, there are not appreciable problems. The reasons for movement and shrinkage within timber are covered in *the drying process*, page 131, but as timber loses moisture the cells shrink and this can cause build up of further stresses that will eventually cause splits or warping. Once this type of log is sawn then the tension and compression is released and causes boards to bend and split, and in some cases to trap the saw during milling. More of this later, but the idea is that conversion of timber with this defect using a saw can be problematic and much of the produce can be unusable as it will be bent and only usable in short lengths, for instance for parquet flooring.

included bark

Some species grow with a main stem that has a tendency to produce deep flutes, and as they grow some bark can be grown over and so included within the stem. Yew and western red cedar are the species that come to mind.

branch bark ridge

Imagine if you will a small sapling with a side branch, they are quite close together. As they grow both stem and branch increase their diameter, and so the inner edges of this branch crotch produce tension and compression wood with the grain going all ways, and some bark can be included within the timber. The external feature shown on the bark is called the branch bark ridge as can be seen in fig 31.

This timber can be used for woodturning and chainsaw carving but for run-of-the-mill building it can cause problems. Fig 32 shows a particularly bad example of included bark in an ash log branch crotch.

fig 31: branch bark ridge

log taper and bend

Some tree species are more likely to develop a rapid stem-diameter taper, for instance Wellingtonia or red cedar. Light competition has a dramatic effect on taper in red cedar, due to allocation of photosynthate. As discussed earlier, see page 16, height gets preference over branches and diameter. So, with this species if there is competition for light the stem grows with almost parallel sides, but in an open situation there will be a severe taper.

As with all logs the millable timber is set by the top diameter for any given length, so with a big taper much of the timber in the butt will either be waste or cut to shorter lengths. If you were cutting seven foot boards from a seven foot log then the position of the first cut would be worked out from the centre line of the log and at the smallest end, hence there would be more waste at the butt end on a log with severe taper.

fig 32: included bark

Log bend has a similar limiting factor on the conversion efficiency of a log in two ways. It reduces the size of any post or beam that can be obtained by conversion by sawmill, because saws cut in straight lines. The use of hewing techniques can improve this efficiency by allowing the bend of a post to be incorporated into the line of a wall. There is more detail about this later in the *hewing* section, see page 80. A further limitation is that it is desirable for the grain (as covered earlier) to be in line with the board. In the grain example photo, see fig 13, page 31, this shows a cut through a bend in the log. This is shown as the grain on each successive growth ring stops short of the previous ring. As this dries it will cause warping, and as the grain is quite short, travelling from one side of the board to the other in less than eighteen inches, it gives rise to a structural defect where the grain can sheer apart, almost like a fault line.

This can also be seen in logs where the tree had large basal buttresses, so boards taken from the butt end display this grain pattern that makes the end of the board quite useless for anything beyond packing-grade timber. In the UK we always fell trees quite close to the ground to make extraction easier, unless you are a tree surgeon or felling a tree in an old hedge line where there is a good chance of finding included fence wire in the tree. When you see felling in America they always seem to start felling above the buttresses. I can only assume this is to avoid including this buttress grain in the log and so reducing the log value. They use the Hobart sink cut that is inverted from the cut we use, so that the sink taper cut is left in the stump rather than on the butt end of the log. Using it has a beneficial effect on the volume of timber available from the log but the effect is negligible unless applied to very large trees where the sink cut can be quite large and contain sufficient timber to make the boards shorter on the sink-cut side of the log.

frequency of knots

This is about the suitability of a particular log for a certain job. We have already covered knots several times, but you have to be aware of the limitations they impose, for instance the stakes used for tree planting tubes need to be cut from good timber because a 1 inch knot in an 1¼ inch post will mean there is a fair middling good chance that the stake will break on the first strike of the hammer.

epicormic growth

This is secondary growth that develops on the stem of a tree after pruning or when the light levels improve dramatically after a severe thinning. The growth comes from adventitious buds that are dormant under the bark until growth begins after a change of some sorts, either damage or environmental change. These are beneficial in pollarding and coppicing as this is how regrowth starts, but not in certain species after a thinning. This growth is most noticeable on oak and poplar, but other species will react in this way. In oak epicormic growth can start the production of pippy oak, where the timber is full of little spirals and dots of branches that never made it. This can be a good thing as there is a demand for this type of oak, but not if you wish to grow good, prime timber for joinery, shipbuilding and structural work. To get good pippy oak the light levels must be reduced in a relatively short time to prevent large branches being formed.

fig 33: a pippy oak log

signs in the bark

Looking on the outside of the log for defects is the primary way of discovering if the log is suitable for your purposes. This could be either good timber to suit the job intended, too good and hence may well be too expensive, or of insufficient quality. Marks and swirls in the bark will tell of damage in the past or branches pruned. Figure 34 shows a bark rose where a branch was pruned from one of our oaks ten years before this picture was taken. Note if you will that the remnants of the bark ridge is just visible above the rose. There is not much more to say about that beyond make sure you look for the obvious and then look beyond the obvious.

I sold an oak log to a mobile sawyer with the express information that there was iron in the butt. It had been a hedgerow tree and lazy unthinking landowners or tenants think it's clever to save fence posts and nail wire to hedge line trees. Gamekeepers can cause timber degradation in a similar fashion, and there is an estate the topside of Scunthorpe where I am the forestry consultant and their gamekeeper has ruined several really nice oaks by nailing release pen wire to them. Back to the story, the oak in question was sold at a relatively low price because of this wire (less than half price). The sawyer did not bother to inspect the log properly or dig into the suspect area with an axe and then whined incessantly when he lost teeth on his mobile sawmill blade. If he had looked properly he could have rejected the log and saved considerable bother and hassle. Steady away, you cannot please them all.


fig 34: bark rose

species and their properties

The various tree species grown in any locality have different site requirements, growing strategies and timber properties. For the home timber converter the form of the tree (shape) and the timber properties are the important factors. There are some generalised rules on the timber properties but these are affected by the site conditions, latitude and the rainfall. I will give you an example; Wellingtonia grown on the west coast of England will grow much quicker than that grown on the east coast where it is colder and dryer. As a consequence of this the west coast timber has much wider annual rings and so is the next best thing to high-density polystyrene, whereas that grown in the east is much denser and therefore has better working properties. This information is not comprehensive but built up over years of trying various timbers and using what is available. Bear with me here, and if your experience is different to mine then it's your own experience and as such very valuable.

oak

Slow growing and the width of the sapwood and the annual rings give a clue to the growth rate. Maturity is at about 150 to 200 years. The timber is mostly durable and the slow grown logs with narrow rings and small springwood cells have great durability. Liable to shake on thin or dry sandy soils where there could be a summer moisture deficit. Brown oak infected with the beefsteak fungus demands a premium.

The sapwood is not durable and is unsuitable for any external work; for internal work it is liable to woodworm infection.

The timber is dense, easy to work when green but increasingly difficult as it dries. It will only take nails when green and the tannic acid in the wood will attack steel. When quarter sawn the timber reveals the silver medullary rays known as featuring.

For joinery there is no crush factor when cramping joints which means the timber will not compress to take up minor inaccuracies in a joint, and there can be movement in the timber even in kiln-dried stock (expansion or contraction due to absorption or loss of moisture). For floors the boards need to be naturalised by bringing them into the finished building several weeks before laying (fitting) for the boards to change size in the new environment.

This is of course pointless if the building is damp from recent building works and so the floor laying should be postponed until it has dried out. This heavy timber dries slowly even in a kiln and a slow schedule should be selected. Air-drying in a north-facing drying shed is recommended prior to loading in the kiln.

uses

Fence and gate posts, furniture, flooring, stairs, doors and internal joinery, timber framing for buildings, roof shingles, clap boarding and siding, beams and posts, firewood and food smoking shavings.

ash

The growth rate varies widely from annual rings of an eighth to three quarters of an inch. This timber is not durable and so is not suitable when in contact with the ground. There are several types of ash and the difference between them is denoted by the heartwood colour; white or olive.

Traditionally ash was commonly used as fence rails in conjunction with oak posts. This tree has one of the lowest moisture contents when green hence the old advice that green ash burns well. This is mostly true but much greater heat is produced from properly seasoned firewood. The freshly sawn boards can split down the heart once removed from the saw due to the tensions within the timber. The low moisture content means that although the wood is naturally springy it has little give, hence the splitting. This natural springiness combined with its hardness means that this timber is ideal for all tool handles and sports equipment, for example the hurley bats used to play hurling.

Fig 35 shows a very slow-grown ash log and the natural splits that occurred soon after felling. Note the close annual rings.

uses

Internal joinery and floors, fence rails, tool handles, timber framing, chair making, traditional wheel making, cart bodies, motor vehicle wooden frames, firewood.

sycamore

This tree grows quickly in a variety of situations. The timber is non-durable and suffers from fungal infections and spalting. It will not store in log form

fig 35: split ash log

in the yard and so must be sawn quickly. The felling season is very narrow, late November to early February, as the early rising sap when the tree comes out of its winter dormancy has a high sugar content. This is a delight to fungus, which will grow rapidly on this food and make the timber spalt very quickly. The shelf in fig 26, page 57, is sycamore showing the loss of white colour and the fungal infection.

This timber dries easily but care is needed to keep the fresh timber white. The freshly cut boards must be stood on end and make sure all the sawdust is brushed off or the bright white colour may be lost. The timber is hard once dry, kiln dries well but is susceptible to woodworm infection. The timber for the shelves mentioned above showed several woodworm holes but I still wished to use it. The answer was to put the boards cut to finished size in a deep freeze for three months. Sycamore takes stain and finishes well as there is no oil or resin to prevent absorption, it also glues well. The grey squirrel attacks this tree and the wounds let in rot that will stain the heart.

Fiddle-back sycamore is found in random trees where a ripple can be seen just the under the bark. This is prized for its use in veneers and so demands a premium price if identified.

uses

Joinery, turning, decorative work, packing and dunnage.

Norway maple

Same as sycamore but the timber is much harder.

poplar

A quick growing timber with high moisture content when green which attains a large size within sixty years. It is white to pale magnolia in colour with red/brown/purple streaks in the heart of large logs. The logs will retain sap for quite some time until converted and then will dry quickly and evenly due to its open fibre. The log cross-grain structure prevents splitting when being dried.

The colour of large logs means that, with the correct stain, poplar will look very similar to walnut at about half the weight, hence west fen walnut. It is non-durable and susceptible to woodworm attack, but it will accept preservative well. The timber takes glues, fixings, stains and finishes without problems. Poplar has been used for lorry floors as it does not crack or tear in use and is lightweight when dry. Poplar veneer is used in vegetable and fruit crates.

uses

Internal joinery, stairs, transport dunnage, packing, pallets.

beech

A heavy and dense non-durable timber with no real features, the main uses for this pale, honey-coloured timber are for joinery, kitchenware, turning, and the frames for quality sofas and chairs. All school desks were at one time made from beech, and the chair factories around High Wycombe in the Chilterns used vast quantities for spindles and legs. Although very hard the timber suffers from short grain that reduces its structural strength and is also susceptible to fungal and woodworm attack. Spalted beech is sometimes sought by woodturners to give feature to an otherwise quite uninteresting wood. The logs will not store well in the yard and must be converted without excessive delay.

uses

Internal joinery, veneers, turning, kitchenware, furniture, transport dunnage.

alder

A tree that grows well in wet areas, it has orange/brown coloured timber of medium density depending where it has been grown. It is partially durable and so is useful for many jobs that do not involve direct contact with the ground. It is used for piles in the Norfolk Broads where it rots off above the water line but below this retains the banks. In the right conditions it grows tall with considerable girth. This timber dries well and is fine grained.

uses

Joinery, building, transport dunnage, pallets, charcoal.

birch

A quick-growing tree that produces white, non-durable timber; the logs should be converted quite quickly to avoid spalting. The bark is waterproof and so this prevents the timber drying and encourages early stages of rot. Birch used to be used for brush heads and other turned goods (like egg cups) as it is cheap, turns well in a lathe and is quite dense. The logs were delivered with the bark removed in three strips, or blazes, along the whole length of the log. This was to enable the drying process to start and so prevent spalting of this white timber, which is an early sign of decay.

The hard white wood is used in plywood, parquet flooring, and furniture. I have seen birch built into small mud and stud cottages in Lincolnshire where whatever local timber was available was used. Birch will be readily attacked by woodworm and other wood-boring beasts.

uses

Joinery, flooring, dunnage.

sweet chestnut

This wood has similar properties to oak and looks very like it except it does not have the radial silver medullary rays of quarter-sawn oak. This species is also more susceptible to ring shake than oak above about twenty inches in diameter. Spiral grain can be a problem and in severe cases evidence of this can be seen in the bark of larger trees. The sapwood is not durable but the heartwood is. It was common for sawmills to add sweet chestnut boards to an oak consignment if they thought they could get away with it, as chestnut is a cheaper timber. The temporary chestnut 'pale fencing' is made from cleft or riven small-diameter coppice wood.

uses

Fence and gate posts, chestnut pale fencing, furniture, flooring, doors and internal joinery, timber framing for buildings, roof shingles, clap boarding and siding, beams and posts.

cherry

For good timber this tree should be grown only on the correct well-drained sites. I worked on a site near to the East Midlands airport, just at the back of the race track. In this woodland the soil changed from heavy clay to sandy loam, so the cherry was good, straight and reaching for the sky on the sand side, but poor on the heavy soil. Cherry spreads easily by root suckering and so many of the trees in a wood may be genetically identical as there is a good chance they are all the same tree.

It suffers from bacterial canker that affects growth and the timber, commonly where the site does not allow the trees to grow with vigour. The timber is not durable but reasonably hard and suitable for furniture, with good colour and feature. It dries reasonably well and is stable.

uses

Furniture, turning.

Scots pine

This is the tree that forms the backbone of the northern softwood timber industry. It is imported in huge volumes where it is referred to as redwood. The tree grows well in the UK and for some purposes it grows too well with wide annual rings. Slow-grown Scots pine has durable heartwood that contains a good proportion of resin; the resin can at times make the freshly sawn timber almost look translucent. It is this resin that is used to make turpentine and Stockholm tar.

When knot free this is an easy timber to work and stable once dry. Blue stain fungus can be a problem in the sapwood when drying slowly.

uses

Construction, joinery, pallets, external work when treated.

Corsican pine

This grows much faster and taller than Scots pine and the green timber weighs more. The knots are courser in open-grown trees. The timber suffers from spiral grain and blue stain. The sapwood is wider than in the Scots pine hence the greater blue stain risk. Not to be used for wide boards due to the spiral grain.

In the late 1980s there was the uncommon situation with a building boom and a low-value pound. This made imported timber expensive and so there was a huge demand for homegrown softwoods. I saw what looked like fresh-sawn Corsican pine being used in loft conversions. The upshot of this was that the warm conditions in a loft combined with green timber promoted the blue stain to such an extent that it travelled through the new plaster. Outcome: wide blue stripes in the new plaster showing where the studs were.

uses

Building, external work when treated, pallets.

Austrian pine

Grows big and was planted on estates as a feature tree. The timber is coarse and similar to that of Corsican pine. Branches and knots can be large. A windblown example on a nearby estate produced three twenty-five foot logs with a final top diameter of twelve inches.

uses

Building, external work when treated, pallets.

fig 36: Austrian pine log

Monterey pine

This tree grows quickly to produce a wide-grained, non-durable timber. If left unpruned it will only produce low-grade timber with large knots. It is grown in New Zealand on an agro forestry system where it is pruned to achieve good quality joinery timber. I have used some in the past 4 x 4 inch cross section, sixteen foot long without a knot or blemish, ideal for newel posts. We have some of these trees in the backyard, they have grown to thirty inches in diameter in twenty-five years but they are real hairy beasts.

uses

Building, external work when treated, pallets.

Douglas fir

In the right situation this tree grows fast and produces good timber. The heartwood is durable and the timber when dry is stable and hard but prone to producing splinters. It is nice to work with and I have used it for stairs and windows. It will take nails only when fresh sawn. There is a slight pink tinge to the timber.

The tree grows well but does not like exposure to the growing tip, which will make it bend over. The dead branches are durable and must be removed to grow joinery grade timber. The heartwood is resistant to preservative treatment.

uses

Building, joinery, dock timbers and piers, sea defences.

larch

There are three types of larch – European, hybrid and Japanese. The durability is best in the European and worst in the Japanese. The growth rate is the inverse of this but the European still grows at a good rate on suitable sites. All are prone to butt rot once they are over sixty years of age.

The logs can be susceptible to spring when milled (see page 100 for details of spring). A red to pink timber is produced from a tree that holds on to its dead branches and so can be dead knotty. The timber dries readily and, depending on the growth rate, can be suitable for window construction. Top quality and knot-free timber is used for outside cladding of timber boats, hence the term 'boat skin larch'.

uses

Building, external work, pallets, joinery, boat skins.

Norway spruce

This tree grows fast and produces a non-durable white timber, known in the imported timber trade as whitewood. Figure 12, see page 30, is of a pruning cut in a Norway spruce board. The timber is used for joinery and building but it does not take stain evenly and so develops a blotchy appearance. Top quality spruce is used for soundboards for musical instruments. In generations gone by the logs were left submerged in a pond for the sap to dilute and for bacteria to break down the inter-cell valves (torus). This produced the very stable timber required for violins. The tree can grow large and mills easily. Spruce is prone to woodworm attack and if there is pine and spruce in a building it will be the spruce that will have turned to powder.

uses

Building, external work when treated, pallets.

Sitka spruce

This grows very quickly in the right conditions with a high rainfall. The west coast of the UK is ideal but here in the east it will not grow well at all. The needles are very sharp with a blue tinge and behave almost like natural Velcro. The wide annual rings of this quick growing species mean that it is not very strong and so section sizes should be chosen accordingly. It is susceptible to woodworm attack.

uses

Building, pallets.

western red cedar

This tree can grow with a significant taper to the stem and large buttresses unless it is grown in close competition with other trees. The red heartwood is durable, light and stable. It bends easily when green and dries well and evenly. This is a shade bearing (shade tolerant) species that will continue to grow in the reduced light levels that can be found in woodlands where the thinning has been delayed. Due to this ability the lower branches only die off under very dense shade conditions and so there are few dead knots within the timber, but there may well be an abundance of live knots.

The timber is lightweight, not dense, with an open grain. It is ideal for building and weather boarding. I have made windows and doors out of it but it is not suitable for small-section joinery. It can be difficult to plane by hand due to the open grain and the frequent small, live knots.

uses

Building, external work, pallets.

Lawsons cypress

This tree is similar to the western red cedar to look at but the leaf scales are smaller and darker. There is the same risk of stem taper and multiple stems that will reduce conversion efficiency. The timber is pale to white and comparatively dense with a recognisable smell. It is naturally durable; dries reasonably well, but can move when milled to trap the saw. This is called spring and is covered in detail on page 100.

uses

Building, external work, pallets.

Monterey cypress

A very durable timber with light annual ring structure, it is honey coloured, medium density and stable; it dries evenly. I have milled a log that had laid on the floor for ten years. The lower sapwood was almost gone, but the heartwood was as good as new. This is a tree that produces beautiful timber everywhere except in Monterey where it is hairy and scrubby.

uses

Building, joinery, external work, pallets.

Leyland cypress

A timber that is wet and sticky when fresh felled, which dries well to produce a stable honey-coloured timber with defined annual rings. Durable and useful but the tree is inclined to produce multiple stems in a similar fashion to Lawsons. The tree is shade bearing (shade tolerant) and so the majority of knots will be live. I have seen a stand of this species in Nottinghamshire and it is like walking into a cathedral.

uses

Building, external work, pallets.

western hemlock

This tree produces a hard and even-grained, pale-to-light-brown timber which is not durable and can be dead knotty. I have only used joinery grade timber of this species, where it is very hard but can give an excellent, smooth finish.

uses

Building, joinery, pallets.

cedar

The main species grown in the UK are: deodar (Himalayan), blue (Atlantic) and Lebanon cedars. They are all grown as ornamentals. I have used deodar cedar that came from Bagley wood, just outside Oxford. The timber is a deep honey colour; it has a high essential oil fragrance that stays with the timber for a long time. Twenty year-old off-cuts still have the perfume. It is durable and slightly oily. We have made stairs out of it, and when the plasterers have finished, the resulting drying process has pulled some of this oil out of the timber; despite it being kiln dried before use.

uses

Building, joinery, external work, pallets.

conversion methods

There are various methods of converting logs into different sizes for building and other utilitarian uses; the method used depends on the final use of the timber, the equipment available, the size of the logs and the time available. In general there is a time-to-expense gradient. The longer it takes, the less equipment needed and so the more likely it is for the investment to be lower in financial terms. This, however, may not always be the case if a holistic view is taken. We are talking here of knock-on effects and the fact that you could use the time more efficiently (opportunity cost). You know what I mean, time taken when there are another 100,000 jobs to be seen to and they just keep building up interminably. In my opinion that is just life and at some point you have to downsize in the nature of your projects or (more likely) the way you view things.

The use of timber in the round for building is one way of reducing timber processing but there are several problems with this approach. These are sensitive issues that can create much debate but hey ho, this is the way I look at it. Using timber in the round is great for simple barns, fence posts and the like but for building it can create problems with creating flat surfaces and efficient use of resources. For instance bark must be removed to reduce insect attack; sapwood can also be a source of both insect and fungal attack as it is not durable, so the majority of this needs to be removed. The way to get around these issues whilst still keeping to a low-processing ideal is to use either hewing or cleaving techniques with, amongst other tools, the side axe and froe. The hewing technique can give a great advantage as you can use small diameter produce, that would be inefficient to convert with any form of saw, but is just the right size for that particular piece in that particular building. We will be taking about conversion efficiency later, but hewing allows certain flexibility in the use of flat surfaces and working with bends within the log. Saws by their very nature cut in straight lines so can waste timber when converting small diameter logs. To explain this concept: imagine a timber-framed, single storey house with support posts. The corner posts need to have two flat faces at ninety degrees so that the post can create the outside corner feature. The intermediate posts used along the line of a wall only need to have two flat faces. One flat face on the inside and the other on the outside of the wall. This means that the post faces within the wall are not seen and do not make up the flat faces of the wall. Hence they can be rough or follow the curve of the log. In this way bent logs can be used but only if the hewing technique is used.

hewing

As with all log conversion the first task is to identify the form of the log and how it can be positioned to get the best out of it. The log is set on bearers to lift it off the ground and held in place with large steel staples called dogs. The ends of the dogs are not pointed but similar to a chisel edge. These edges are at ninety degrees to each other because the grain will be running in different directions on the bearer and the log. The chisel ends of the dog are driven into the grain not across it. Fig 37 shows a small timber dog in use.

fig 37: timber dog

The first cutting operation is to create a flat face along the log length; from this all other cuts and faces are measured and created. For hewing this is marked out with a chalk line as per fig 38. If you are using fresh-felled timber it is not always necessary to remove the bark at this stage but if the bark makes the marking out difficult then some removal is useful so the line is easily seen. So, we have a log with a line in chalk marking the first cut. The position of this line is judged by the size of the face to be created and the size of the log. As an example – if you have a nine-inch diameter log (measured at a point half way along the log, and so called the mid-length diameter) and you require a 6 x 6 inch square post then the first face will determine the position of the opposite face. So if you take too much off the log creating the first face then there will be insufficient timber available to produce the opposite face of this six inch post. This is where experience and a few moments standing back to evaluate the situation is time well spent.

So, once this line is set, a spirit level is used to transfer it down each end of the log so that the line can be created on the underside face, giving a datum line all the way round the log. It's easier to do than describe, so I have included a setting-out photo showing the initial marking out on an ash log.

fig 38: marking out

To consolidate these lines so they do not get rubbed off, they are then cut with an axe to about half an inch deep. This is called scoring and gives a finished edge to any further cutting. The next process is called notching where a series of notches is cut down to this datum line. See fig 39 to get the idea. This can be done with a felling axe or large hatchet. The photo also shows the continuing process where those portions of the log between the notches are removed with a side axe, producing the first datum face edge. It is useful to mark this face so that all further marking out is measured and transferred from this to prevent inaccuracies building up. That's enough about hewing as the whole book could yet again end up covering the intricacies of this subject. The main idea is to create a flat face, the correct distance into the log from which all other cuts are taken and which also provides a flat stable base so that the log has less tendency to roll or move during the rest of the process.

fig 39: hewing notches

cleaving

This is basically splitting timber down its length so that the split faces primarily follow the grain. It keeps the grain intact and so all the cells are complete and hence, theoretically, results in a more durable product. When making hurdles the long whippy pieces that are woven between the uprights are called weavers. Cleaving is used to split over-large weavers when making hazel hurdles, or for splitting laths for lime plaster ceilings and walls. Chestnut paling, temporary fencing is made from coppiced sweet chestnut that is cleft from relatively quick-grown and small-diameter material. A froe can be used for this work, and because the handle is square with the blade then a levering action will expand the initial split, see fig 40.

fig 40: cleaving shingles

Oak, sweet chestnut, or western red cedar can be cleft to produce roofing shingles. For this use the timber needs to be of good quality and knot free to produce wide, even and relatively thin shingles.

history

In centuries gone by there were methods of producing sawn material from logs with the use of various hand and semi-mechanical means. In Britain many of the larger villages had their own collection of tradesmen that served the local area. The village carpenter's shop looked after many of the needs including funeral services and made coffins as required. Each

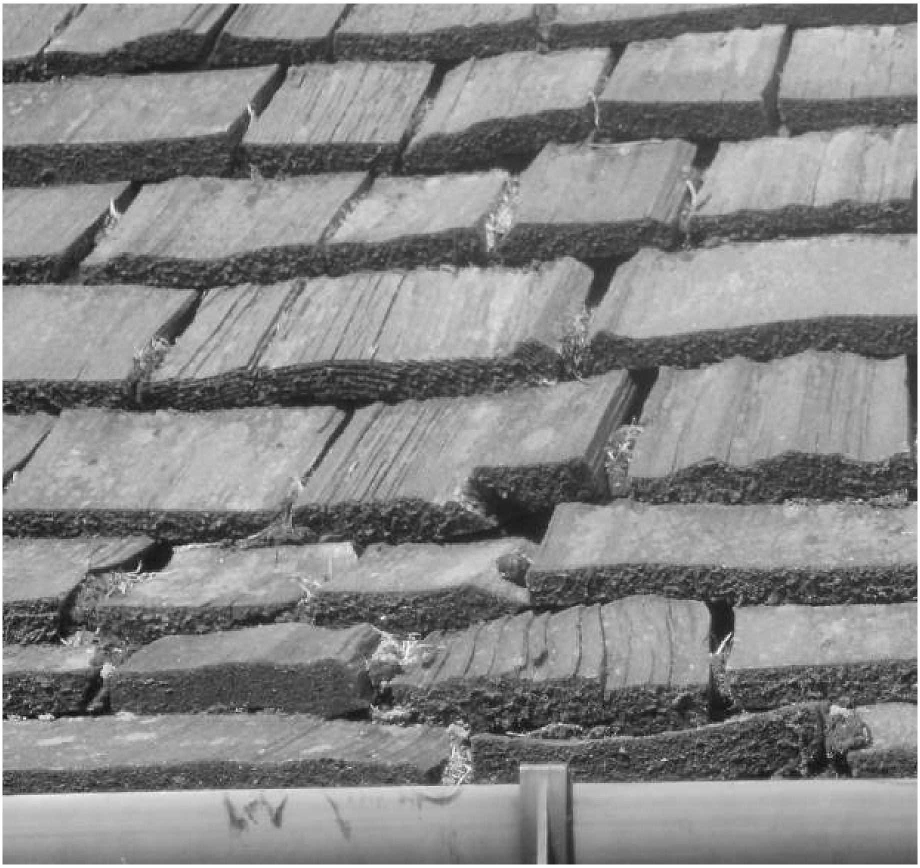


fig 41: cleft shingles

yard had its own saw pit and itinerant sawyers would call at regular intervals to spend a week converting logs brought in from local woods and field edges. They brought with them their own tools including the pit saw, which was long and tapered with a tiller handle at the wide upper end and a removable box handle at the lower pit end. A man would work at either end, with the more experienced man on the top of the log away from the falling sawdust.

In the US no doubt log sawing came from a similar history and Robert Pike goes into this in some detail in his book *Tall Trees, Tough Men* about sawing and sawyers. He covers the whipsaw which was the progression of the pit saw in that it was driven from a cam or crank on the end of a slow-running water wheel or animal-driven device. This saw used a whippy pole, in the same way as with a pole lathe, to lift the saw and the power is used to pull the saw down on the cutting stroke. In both cases the cutting is only on the down stroke, so in the case of the pit saw the upper man was there to lift the saw and to guide it on the downward cutting stoke along the pre-marked chalk lines.

fig 42: pit saw

I was wandering through a local market town past a junk shop (it's not there anymore), and there on the pavement was a shelf of books for sale, this book (*Tall Trees, Tough Men*) caught my eye for no apparent reason, as the cover is not really eye catching. However it turned out to be a history of logging in New England and as such has been both entertaining and informative. The characters flood out of the pages, such as Ginseng Willard, a woodsman who made his own coffin out of a rosewood piano and slept in it for two years just to get used to it, and also tales of logging camps and river drives. Many of the people who work in the woods and the timber trade have their own peculiarities, I know of a fair few who have their own attitude to life. You have to get to know them to learn the rules by which they have chosen to regulate their own interaction with reality. Still, back to the subject in hand.

mechanical methods

What follows now is a selection of possible mechanical conversion methods. It does not cover all possibilities, but goes instead for general concepts and gives examples of equipment available. Whilst the photos show a particular make there are other makes available that use a similar technology, so these are examples rather than recommendations. This section does not go into minute detail and as ever when buying equipment it can be the small details that make all the difference. However these machines are being constantly developed and so detailed advice given now may be out of date in a few years time. The other option to buying new is to buy a used machine and this opens up a whole new learning curve.

chainsaw mill

There are several chainsaw-based attachments and machines. They vary between the simple frame that bolts on to a medium-to-large chainsaw to the machine that holds a chainsaw bar and chain combination, drives the chain from it's own power source, has self-feeding for the chain milling and a rise and fall log rack.

ripping saw-chain

First we need to cover a few details about saw chains. The standard saw-chain is designed to be multi-purpose in that the filing angle of the cutters is between twenty-five and thirty degrees depending on the type of chain. This multi purpose design is for cutting across and at an angle to the grain but not along it. When using a chainsaw for milling the saw is cutting along the grain (ripping) and this is more difficult than simple crosscutting as with ripping the saw is cutting along those fibres that we talked about earlier. To make this process less arduous the angle of the cutters needs to be changed to ten degrees. This angle change will also be covered in the circular saw section when considering the tooth profiles. The change of angle means that the chain cutters are now more like a series of chisel edges and this cuts down the grain more efficiently. You can either buy a ripping chain for your saw or take a part-used chain and re-file the angles to suit.

fig 43: chainsaw chain and filing guide

Now, just a brief word about sharpening the cutters on a chainsaw; chainsaws don't have blades, they have a bar and chain. The size of the chain dictates the file size used to sharpen the cutters and the depth-gauge setting tool required to file the depth gauges to the correct height.

The file and file holder should be matched to the file positioned so that one fifth of the file is held above the cutter (top plate). This gives the correct undercut to the top plate. So, briefly, for a 325-pitch chain (that is 0.325 of an inch) the file size should be 4.8 mm (3/16") and for a standard ⅜ pitch (⅜") (not picco) it should be 5.2mm (13/64") or 5.5mm (7/32") depending on the make of chain. Picco chain is a lightweight ⅜ pitch chain with small cutters used on small chainsaws, and the file size is 4mm (5/32"). If you stopped listening to yourself when reading this section, then that is a clear indication that it's time to get some training. As I've mentioned before until your chain will cut straight and efficiently, don't continue.

kerf

This is the width of a cut; the wider the kerf the more timber is wasted. For example if the kerf is ⅜" then for each (say) 1 inch board cut it will use 1⅜" of timber. It does not take long to lose several boards' worth of production in a wide kerf. I will be referring to this frequently in this chapter.

types of chainsaw mill

The types of chainsaw-based mill can vary between a very simple-looking frame to a larger and more complex unit.

A simple chainsaw frame is hand fed along the log using some form of straight edge to get the first flat cut; all other cuts are made from this cut. By the very nature of this method it is slow and takes considerable effort on behalf of the operator, and it is noisy. It also uses quite a lot of fuel and chain oil, and, with the bigger pitch chains, the width of the cut (kerf) is wide, so timber is lost to that big pile of chippings on the floor. The benefits are, however, considerable in that if you have a medium-size chainsaw already then the frame is quite inexpensive, is easy to transport, and using it means that logs that could be difficult or expensive to move can be converted on site, changing a large heavy thing into many smaller and easily-lifted pieces. Once again you have to make a time-over-effort-and-machinery-expense cost benefit analysis, but a log that is expensive to extract for the owner will be much cheaper if you buy it where it lies.

The other end of this machinery selection is the machine that takes either a large chainsaw or uses a bar and chain combination driven electrically. These machines have either hand-crank or motor-drive feeds so that all that pushing on behalf of the operator is no longer necessary, which is a good thing. The petrol chainsaw based units are quite mobile in that they are easily taken apart and rebuilt, but because the frame takes the weight of the log it must have sound and stable ground. If this is not the case the frame will twist as the feet sink and the boards will be cut with a twist.

bar and chain choice

I have seen a Logosol unit that is powered by a generator in a local social woodland setting. The bar and chain combination was ⅜ picco. This means a small lightweight chain with low profile cutters, but still ⅜ pitch and a different file size (you should know this). This unit was only used for relatively small logs and so this lightweight combination was ideal as the kerf was much narrower. The use of ⅜ picco was possible because of the small log diameter. If large logs were to be milled then a longer bar would be needed. With a long bar there has to be greater support and so larger chains and thicker bars are required.

Alaskan type mill

This is a relatively simple lightweight frame in which a chainsaw is mounted. Figure 44 gives the general idea. This type of mill cuts through and through. In other words the bar has to extend all the way through the log and so cuts slabs that can then be re-cut to smaller size. It is important for the bar to extend all the way through the log so that the chippings can exit the cut at the bar nose rather then being carried all the way back round to the engine. If this were not the case the gullet of each cutter would fill with chippings and create a huge amount of drag, which would reduce cutting efficiency.

So to use this style of equipment it is necessary to work out the position of, and then cut, an initial flat face. With this conversion method, where the saw is guided by the previous cut, it is necessary to use a guide to provide this function for the first cut. The manufacturers provide a rack to fulfil this function but a ladder or a board that is sufficiently rigid will also work. The main things are that this guide does not move, and so it has to be fixed to the log, and that it remains straight and true. The accuracy of the first cut is only as good as the surface of this guide so if by fixing it you introduce a bend, then that will be copied. It is, of course, important to make sure that the first cut is well away from any nails or screws used for this fixing. See fig 45 where the rack on top of the log is clearly shown, and the saw frame runs on this.

fig 44: chainsaw frame mill

As you can see from the photo, the frame is made up of two basic parts. The top frame that follows the initial guide, and then follows the previous cut face. This also holds the other pieces, namely the two saw mounting columns. These are adjustable within the top frame so that the operator can choose the thickness of material to be cut.

fig 45: first cut with an Alaskan mill

The saw is pushed through the log by hand, so the chain must be razor sharp to prevent an uneven cut, damage to the bar and chain, excess fuel and oil used and undue work required by the operator.

Fig 46 shows a larger model frame needed to support a longer bar. Due to the force needed to feed the saw through a wide timber face there is an extra attachment on the bar nose end. This allows an extra person to help guide the saw, whilst giving proper operator protection.

fig 46: operators and wooden guide rails

For really large timber a double ended bar is available to take a power unit on each end. A very strong chain is required to handle the double power with this arrangement. In fig 47 a winch system is just visible in the top centre of the frame to provide smooth feed and hence a good finish to the cut.

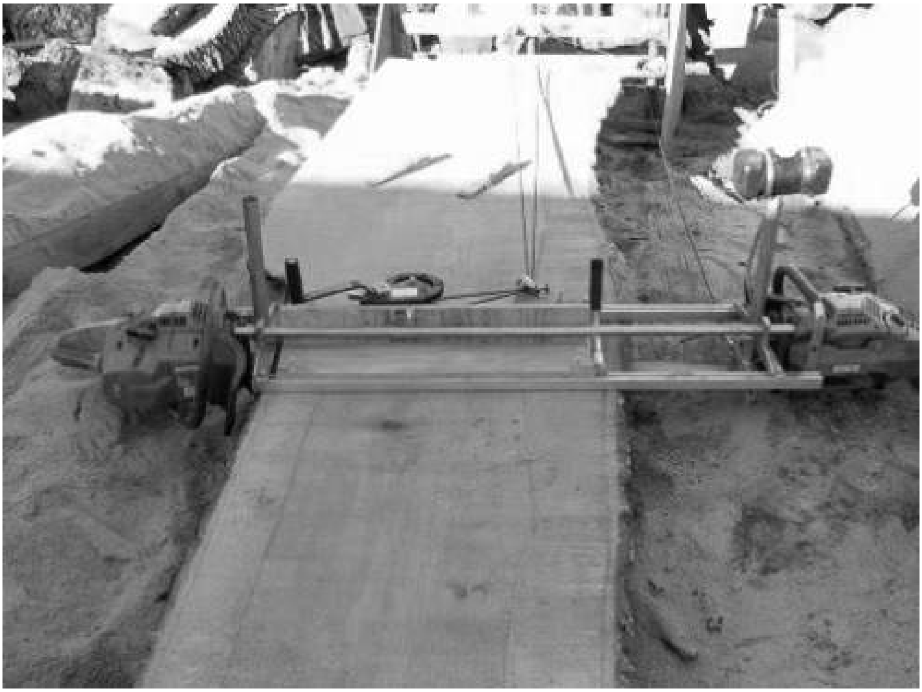


fig 47: double power unit set-up

Logosol bench

This type of chainsaw sawmill takes the flexibility of the Alaskan mill and adds a more efficient and easier operator experience. Whilst still being mobile it is larger and the logs are lifted on to the machine, rather than the machine working around the log.

The feed winch and firmly-fixed chainsaw sliding arrangement means that milling is more accurate and quicker. The saws are attached to the sliding frame head by using the extended bar attachment nuts provided with the sawmill. The fact that the lightweight aluminium frame supports the logs means that in woodland situations the Logosol feet need to be fixed to bearers (pieces of sawn timber) to spread the weight. This keeps the frame stable and twist free to ensure accurate milling. I have used an early model of this saw and found it easy for short run production. The top of the range model with power drive and electrically-powered bar-and-chain combination is better for larger production runs, but only where a generator or electrical power is available. This cuts down the flexibility of the unit and increases the initial investment. The two winches on the log deck make lifting the log for the next cut quite easy.

fig 48: Logosol chainsaw mills

fig 49: Logosol mill

fig 50: log lift winch

There are measurement scales but the winches also click at every quarter of an inch, so counting the clicks is easier. An allowance needs to be made for the kerf of the saw on each log lift. Fig 51 shows the last cut in the production of boards from a previously-sized baulk of timber, as covered later in this chapter in the *basics of log conversion* section.

fig 51: milling boards

Procut

This design varies from the previous two examples in that the main body is based around a low trailer with stabilisers. Fig 53 shows the frame which runs along the rails that are part of the main structure of the trailer. The frame holds the chainsaw and has a rise and fall mechanism to adjust the height of the chainsaw bar. This is a self-build project for those of us who have some backyard engineering skills. The plans are available from Procut and give the option of investing time as opposed to hard earned cash.

The bar is held rigidly from both ends to prevent the saw following the grain and the rise and fall is sturdy. It is worth noting that whereas the Logosol mill lifts the log, the Procut lowers the saw and that the low trailer makes log loading from a set of bearers easier. The wheel on the loading side can be quickly removed if necessary. There are single and double axle options to provide differing bed lengths, hence different maximum log lengths.

fig 52: Procut trailer bed

fig 53: Procut saw-mounting frame

circular saws

A trawl of YouTube will bring up many entertaining, informative, and potentially downright dangerous circular saw based conversion methods. In the small-scale conversion dealt with in this book, the use of circular saws for primary break down of logs can be easily divided into the swing head saw and the fixed saw. Both types have a rack or moving bed but that is where any similarity stops.

swing saw

There are various designs based on this idea, which is that an engine drives a circular saw and the whole cutting and drive train is mounted on a bogie that travels along a track. It is similar to a rack saw except the saw moves on the track and the log stays still, as opposed to the log moving on the track and the saw staying still. Fig 54 shows a Peterson mill with a floor-mounted track, saw mounting-frame and saw head. The obvious benefit

fig 54: Peterson saw

here is that, although it is sometimes helpful to put a log on bearers for stability, with heavy logs this is not necessary. In this case the log did not have to be moved and the saw frame was set up around it; as you can see it is in someone's garden. The whole bogie is adjusted up or down against the rails to give the height of cut, so this is lowered as timber is milled to set up the next level of cuts.

With the swing saw, however, the saw blade and the drive can tilt from horizontal to vertical. This allows a large log to be broken down into various boards and beams, each one being cut and removed individually. This is a totally different methodology to the circular saw covered later. The tilting head means that the log does not have to be turned to achieve the next cut, an operation that can be difficult or time consuming. As with all circular saws the depth of cut is limited by the radius of the saw blade less any shaft and blade-holding boss dimensions. With the swing head the maximum width of cut is doubled because you are cutting from both sides and takes some experience and clever cut positioning to get the best out of a large log. The tungsten carbide tipped saw blades are very different from the standard ripping blade on a bench saw in that there are very few teeth and the gullets are huge to accommodate a significant volume of saw dust.

fig 55: breaking down a large poplar log

fig 56: cutting boards

It is interesting to note that the Lucas form of this mill has an attachment to run a huge bar and chain to cut logs through and through to produce slabs.

fixed circular saw and rack

I have a saw like this with the advantage that it is mounted on wheels but with no brakes, so it makes towing both entertaining and illegal. There's a video of it on my YouTube channel, see *resources*, page 169. The idea is that there is a strong frame supporting a series of rollers and the circular saw blade, shaft and drive. A steel bed runs on these rollers and the log is dogged onto this bed. Pushing the bed moves the log though the saw. An adjustable fence sets the width on any timber cut. The fence is set at a distance away from the blade, and so with the timber running against the fence this determines the width of timber cut. The fence can be seen to the left of the blade in fig 65, page 109.

There is an upright blade at the rear of the circular saw, this is called a riving knife and is there to reduce the effect of a log pinching the blade as it is cut. Certain timbers when milled will 'spring', which means that the cut will either open or close as the saw progresses through the log. In days gone by it was common to push wedges into the cut at the back of a saw to reduce friction or pinching. The top guard on a circular saw is a safety feature for reducing flying debris but also to restrain the log if it springs on to the blade. The rear of the blade is moving upwards and severe pinching can lift the back of the log and if it is not restrained it can be fired forwards over the saw. Remember you could be putting thirty or forty horsepower into the saw with considerable momentum; for this reason the top guard needs to be quite robust. I have seen instances where the log has lifted and been restrained but the force has bent the guard. Don't use a saw without one.

The unit I have is, I suspect, a converted stationary unit from an old sawmill. Go to any sawmill and you can see these log racks, normally used in conjunction with a wide (four inch) band saw unit. The log racks have power feed to give effort-free and even cutting. Fig 57 shows my rack saw and the rollers are clearly visible.

fig 57: rack saw

narrow horizontal band saw

A band saw blade is a band of tempered steel with a set of cutting teeth cut into one edge. There are various options for these blades; width, thickness, number of teeth per inch (TPI), hard point teeth, tipped teeth, tooth profile and teeth that you can sharpen. It's a whole science in its own and I don't propose to go into huge detail, but the TPI is important and the saw manufacturer will give you guidance on the suitability. Fig 58 shows a 1½ inch wide band with two TPI.

The fewer teeth there are per inch the larger the teeth and the greater size there is to the gullet. The gullet is the open area in front of the tooth in which the sawdust collects whilst the tooth is cutting. As a general rule the larger the size of timber to be cut, the less teeth there should be per inch. If a band saw squeals when cutting large material then the gullets are full of sawdust before the end of the cut. This is an indicator that a band with a TPI which is too high has been selected. Where the number of teeth per inch is less than one per inch then the frequency of the teeth is described in terms of pitch, that means the distance between one cutting edge and the next. The band in fig 59 is three quarters, meaning there is three quarters of an inch between each tooth.

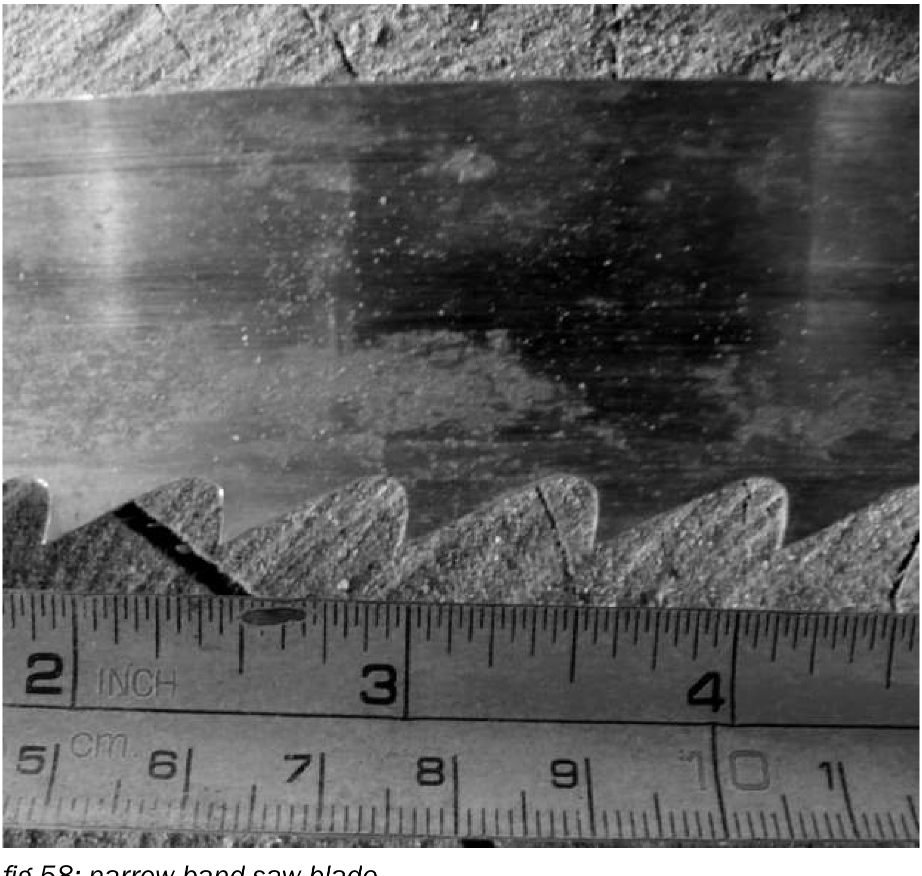


fig 58: narrow band saw blade

The term narrow band saw is a reference to the cutting band saw being about an inch wide, this means that, as referred to later, the kerf is also narrow. These saws are similar to the tilt saw in that the whole cutting head and power plant moves along the bed of the machine and the log stays still. Unlike the Peterson machine, which can cut part way through a log, with the horizontal band saw set-up the cut must continue across the complete width of the log. This method cuts off slabs from the top down as the cutting head is lowered for each successive cutting pass. These slabs can then be turned and repositioned to be resawn to the final dimension. Commonly a narrow one-and-a-quarter-inch-wide band saw blade is tensioned between two large, cast iron wheels. There are blade guides to help to keep a straight cut and thrust bearings to prevent the blade being pushed off the back of the wheels. The tension on the blade is critical and it should be 'pinging' tight. Fig 59 shows the wheel and guide use on a Timbermate mobile band sawmill.

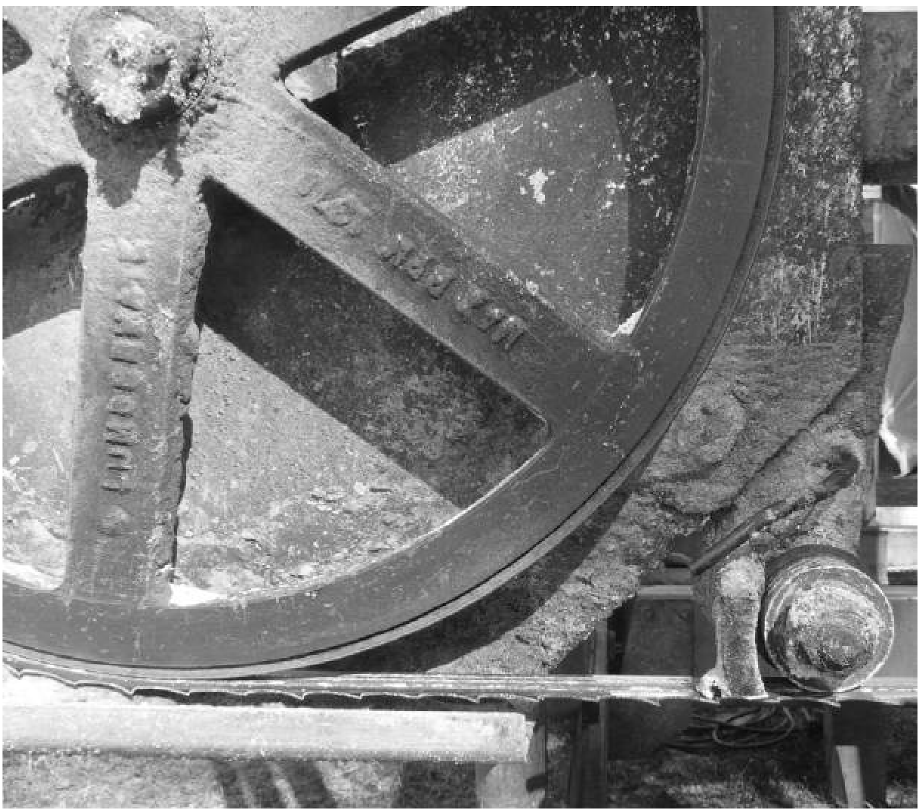


fig 59: band saw wheel and blade guide

Anyone who has used a band saw in the workshop will know that the correct band tension and guide settings are very important to produce even and straight cuts. The kerf of a narrow band saw is indeed narrow at something like 3mm which, when compared to the chainsaw mills, is a vast improvement in timber utilisation.

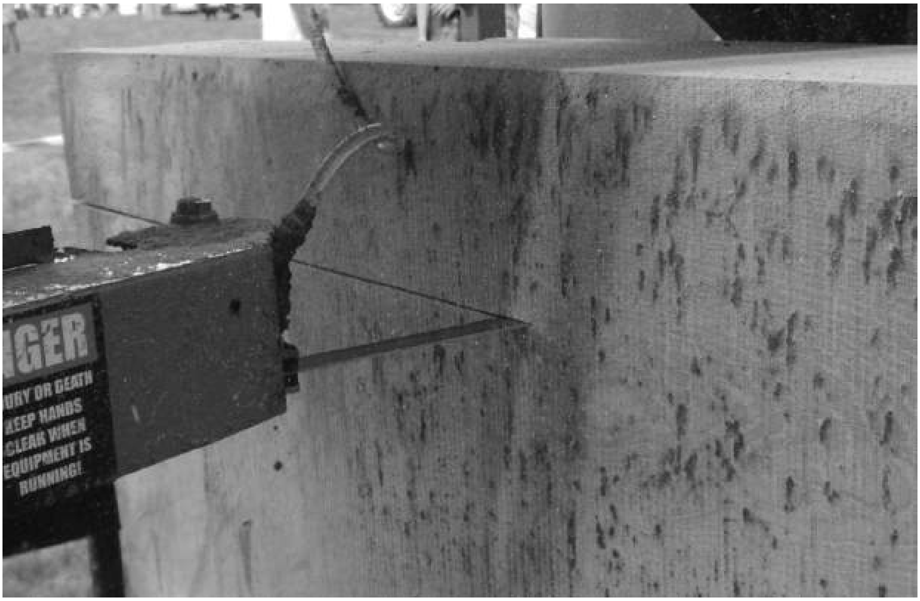


fig 60: band saw cutting oak

However there are several issues to be considered when choosing between the various conversion machines and I will cover these later. With mills of this type there are two basic options, where the bed is either ground mounted as in fig 62, or forms part of the trailer and so mobility is good but access to tight spaces could be a problem. When loading the log is either rolled onto the bed in the ground mounted version, or raised on to the bed in the trailer version by either barrelling the log up some sloping bearers with a winch or, with the top-of-the-range models, they have a hydraulic log lift incorporated into the bed. Fig 61 shows a ground mounted Hud-son mill driven by a lightweight air-cooled engine mounted on the carriage.

fig 61: Hud-son band mill

The Lumbermate mill, see fig 62, is a hybrid between the two being ground mounted but incorporating quickly-detachable axles so that the whole unit can be towed. Some manufacturers also provide machines driven by electric motors that are primarily used in static situations.

fig 62: Lumbermate band mill

the basics of log conversion

We have already covered the basis of the first cut to provide a flat face, from which all other cuts are measured. For this example let's imagine we are cutting boards six inches wide by one inch thick (6 x 1) for external cladding (siding) and we are using my rack saw. So the first pass cuts the flat face; this cut face needs to be at least seven inches wide so that the ends of the first board have no waney edge, unless you want some. Just to explain that term; a waney edge is where the natural form of the log, with or without the bark, is seen on the edge of sawn material.

The second cut is at ninety degrees to this first, so the log is rolled and then positioned so the outside of the log is removed and the second cut meets up with the end of the first cut, see fig 64. This second cut can also be seen in fig 46, page 92.

fig 63: first cut

fig 64: second cut

At this point the fence is set to six inches and the log rolled again through the mill to cut the third face. Once this is cut then the six-inch thick slab can be repositioned to cut it into one inch boards by setting the fence at one inch from the blade. Continue cutting until the whole slab is converted, then start all over again. It is possible to mill the off cuts (scantlings) into small sections as long as you can hold the pieces firmly enough, otherwise they are firewood. The process varies for the different sawmill makes. This final process is also shown in Fig 51, page 96, using the Logosol mill.

I am including, fig 66, a photo of home-milled boards being fitted to a timber building. The small upright piece is a notched jig to set the board spacing, a pair of these is tacked in place to hold the next board before nailing it. The placing of the nails is very important to allow each board to expand and contract with changes in the weather; so the nail just misses the top of

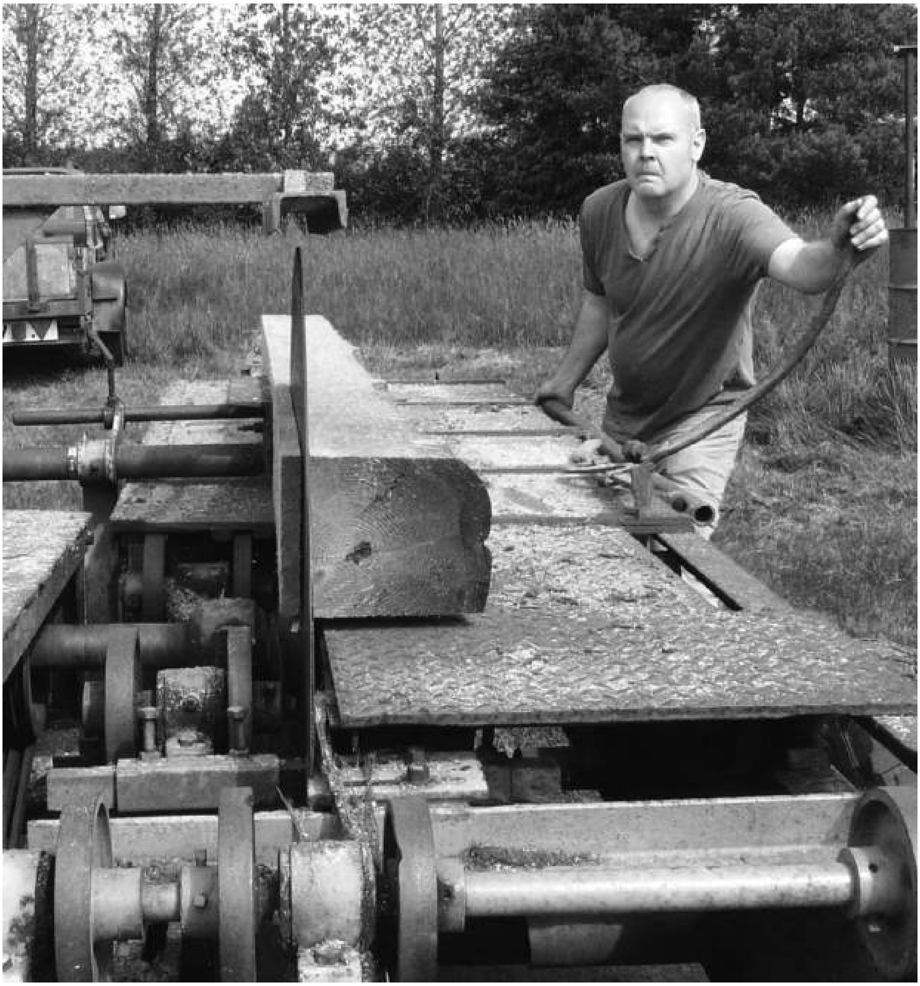


fig 65: milling boards

the board that is being covered and only one nail is used per board in each stud. The top of the board is held tight and in place by being trapped by the next board above. You have to think in three dimensions.

fig 66: home-milled weather boards.

measuring timber

This subject can be neatly divided into two: estimating the volume of round wood and measuring sawn material. It is important to have a good understanding of measuring timber so that you end up actually buying what you are hoping for, are able to estimate the timber you require or can achieve the right returns on the sale of sawn material.

There are many points during the process of turning trees into usable building materials where a measurement or estimate of volume will be required. This measurement can be estimating the volume of standing trees, measuring individual logs after felling, estimating the volume of timber in a stack of logs, or measuring the actual volume of a pile of sawn material. Each is used at different times during the felling and conversion process, primarily to put a value on the wood and to see if there is sufficient for the project in hand or the order you are required to fulfil.

There is also the choice of scale between imperial and metric. In the UK it seems that hardwood logs are mostly sold in hoppus feet or by weight, and softwood logs are sold by the cubic metre or by weight. In the US there is the entertaining board foot, which I believe can be used for both logs and sawn material, and this is where it can get really complicated so I have added some links in the *resources* section for those who really want to know. The board foot is, however, a foot square board that is an inch thick, or so I am led to believe so there would twelve board feet to the cubic foot.

In the UK one of the books used for tree and log measuring using the metric system is *Forest Mensuration* (the blue book) and for the imperial hoppus foot there's the *Decimal Hoppus Tables* by S. E. Wilson. The blue book covers many options for measuring single standing trees, the volume of timber in areas of woodland, or volumes in individual sawlogs (logs suitable for milling) or stacks of logs. There is an easy to use decision-making chart in the front of the book, for selecting the appropriate method depending on the accuracy required and the area or number of trees or logs to be measured. The hoppus foot tables shows the solid contents of round timber in hoppus feet in decimals rather than imperial fractions. People under a certain age just cannot relate to such esoteric fractions as nineteen thirty-secondths or similar. See *resources*, page 169.

single standing tree

To estimate the volume of a standing tree it must be understood that the tree can be divided into several areas, namely the main stem up to the first major fault or branch, the remainder of the stem up to a specific diameter defined by the use that this portion of the tree will be put to and the rest of the crown and branch wood. It is the first and second lengths that millers are interested in and maybe some of the large branches within the crown. The rest of the crown is graded as firewood, although some of it could be milled for rough fencing, etc.

To estimate the volume of a standing tree either Procedure 7 from the blue book can be used or a less accurate estimate can be made using the hoppus system. Firstly the height of the tree is required, either, for conifers, to seven centimetre stem diameter or, for hardwoods, to timber height – timber height being to a point where no main stem is distinguishable. (How can you tell from thirty metres away? Just guess.) The height can be obtained by various methods, all of which require a measurement of distance on the ground away from the tree in question.

The backwoods method of guesstimating the height is to use a stick in the hand of an outstretched arm. The arm must be straight out from the shoulder (forwards and horizontal). Holding a small-diameter, straight stick which is about three feet long in the fist of the outstretched arm, bend the wrist back until the stick will just touch the chin. This gives a stick that is roughly the same length above the hand as it is away from the eye. With the stick now upright in the outstretched hand there should be a right angle (ninety degrees) between stick and arm. Stand at a distance away from the tree so that the top of the fist holding the stick is level with the bottom of the tree, and the top of the stick is in line with the timber height of the tree or a guess where seven centimetres is (for conifers). The height of the tree is then equal to the distance you are away from the tree.

If you are on a hillside then do this estimate standing level with the tree along the contour, not below or above or you measurement will be wildly inaccurate. As you can see, this method works on the principal of similar right angle triangles, where the sides of such a triangle are of equal length. The arm and stick are the same length, and so lining this up with a tree makes another larger equal sided right angled triangle. There are pieces of equipment available to help with this process, for instance the Clinometer, but they have a cost and are only required if you are doing this every day as part of your job.


fig 67: height measurement

The next part of the process is to obtain the diameter breast height (DBH), which is defined as 1.3 metres above the ground and at the highest point if the tree is on a slope or hillside (so you stand on the uphill side). To measure the diameter use a metric DBH tape, where the tape is wrapped horizontally around the tree at DBH and the scale shows the diameter in centimetres. With the height and the DBH then use a ruler on the single-tree tariff charts in the blue book to obtain the tariff number. Then refer to the tariff tables later in the book. It sounds fiddly but it is explained well in the book and ends up being easy enough. There is a method choice chart at the start of the book, for you to choose the correct measuring method depending on what you wish to measure.

You will now have an estimate of tree volume in cubic metres; conversion to other scales is just a matter of arithmetic. For instance, there are thirty-six cubic feet in a cubic metre and this equals twenty-eight hoppus feet.

Now to measure the hoppus foot volume of a standing tree. T. A. Robbie describes a method in his very handy book entitled *Forestry*, see *resources*, page 169. He estimates the taper of the hardwood stem as being by one quarter girth per ten feet of height. Now I know what you are thinking, but bear with me on this. The tape that is used for measuring the hoppus foot content of a tree or (more commonly) logs is called a quarter girth tape. So what Robbie is saying is that for every ten feet of tree take off one quarter girth (one major denomination) from the DBH measurement. To estimate the volume we need the height of the usable timber (timber height) in the standing tree and its mid-length diameter, which means if the height is thirty feet then the mid point will be at fifteen feet. If the DBH is at four feet then it will be a further eleven feet to the mid-length point. To estimate the diameter at this point, subtract one quarter girth from the DBH measurement. Then simply use the book and go to the relevant page for that mid-diameter measurement, look down the chart to the correct log-length line and read off the volume in hoppus feet. Remember hoppus feet only measures round wood. If you had a log ten feet long and you were only just able to cut a 12 x 12 inch beam out of it, then each foot length of log would contain a hoppus foot, and when sawn it would contain a cubic foot per foot run, without measuring the waste. Fig 68 shows three tapes lined up, the top being a centimetre girth tape with each calibration being one centimetre of diameter (not of tape length). The middle one is a hoppus quarter girth tape showing the major and minor calibrations, and the bottom is a standard foot rule showing inches. A quarter girth is four inches and the tapes are lined up to show this comparison.

individual logs

The volume of a single log is estimated by using the log length and the mid-length diameter. Logs over twenty metres or fifty feet should be measured as if they were two pieces to reduce inaccuracies, as would be the case if there is a point where there is a dramatic change in diameter. The length is rounded down to the nearest foot or thirty centimetres.

For the metric system Procedure 1 from the blue book is applied using

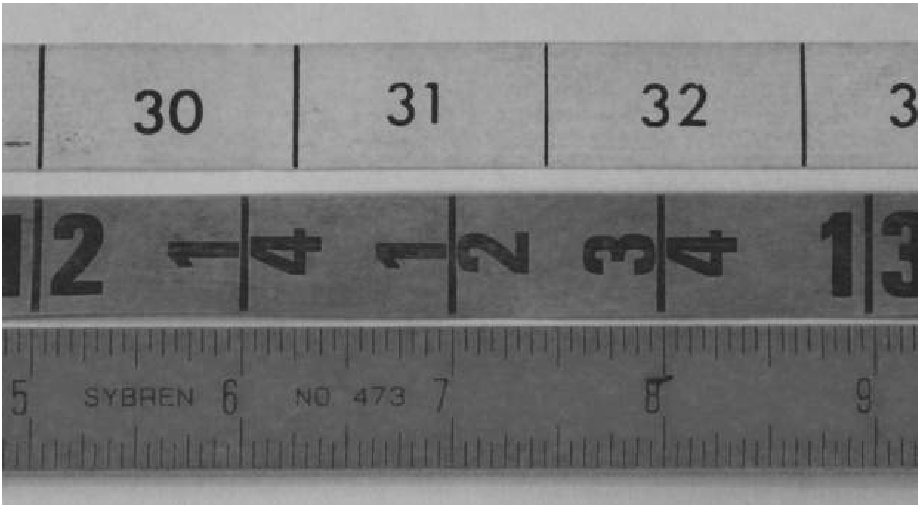


fig 68: measuring tape comparison

the above measurements; the diameter being measured with a centimetre girth tape. For the hoppus foot system a quarter-girth tape is used for the mid-length diameter measurement and the log length measured in feet. Diameters are rounded down to the nearest graduation, the lower figures being read from the tape.

stack measure

Sometimes it is necessary to estimate the volume of a stack of timber, for instance when buying larch for fencing, and it is impracticable to measure each small diameter piece. In this case the stack will be made up of logs of the same length but with varying diameters. The idea here is to measure the volume of the stack, by length, height and width (the length of the logs). For instance with a stack of two metre logs (bars) that is eight metres long and two metres high the stack volume would be thirty-two cubic metres. A stack will not always be regular, especially along its length where it will taper off. This will need to be accounted for and the easiest way is to imagine that if a few logs at the end are transferred on top to create square ends, then the stack would be an even height all along. Having estimated the stack volume, then not all of this is timber; there are gaps between the logs. This is where the conversion rate comes in, and it depends on the species and the size of log. Commonly, however, there is a starting point where the ratio of timber weight to stack volume can be agreed. With a stack of hardwood in log length (unprocessed firewood) the conversion would be between forty to fifty per cent of the volume is weight. So this stack could contain sixteen tons of timber. With softwoods the weight ratio would be between seventy and eighty per cent. These ratios are for freshly felled timber and some species will lose weight rapidly, especially in late spring; Norway spruce is particularly bad for this as over half of the green weight is water.

value

The value of timber varies enormously and I have already mentioned several contributory factors. If the log is difficult to get to with machinery and there would be considerable cost involved in extracting it, then the value is much less because of where it lies. If it is in someone's garden and they are desperate to get rid of it then it is free or you charge to remove it; remembering they may kick up a huge fuss if you cover the garden in sawdust and ruin their lawn. Beyond that it is down to the vagaries of the market and the factors governing supply and demand, the time you have available and your ability to negotiate.

conversion efficiency

I have covered this at various points so far but to bring it all together: conversion efficiency is the difference between the log measure before milling and the sawn board measure afterwards. Several things affect this conversion including, but not limited to:

size of the logs

A large diameter log has more inside compared with the outside than a smaller log and so more boards can be milled from it and there are fewer boards that have a waney edge. It is also more efficient as there is less turning of the log during processing. For small logs it may be, for example, that only two pieces of sawn material are obtained. In this case more actions are needed per piece and there are still four outsides of the tree (slabwood) left over.

length of the logs

It is ideal to buy logs of the right length to suit the specification of the finished product. If the logs are two feet longer than you need then that is two feet of waste. This is why it is easier and gives greater flexibility to obtain timber in as long a length as possible. You can then cut it to suit your needs.

size of the sawn material

This not only fits in with the previous point, but the smaller the sawn section required then the more timber is wasted in the kerf, see page 88 for definition. There is also more time taken in turning the log or re-cutting slabs or baulks and more time handling and stacking the produce.

type of saw

This has to do with the kerf and the type of saw; if the kerf is wide then more timber is lost to sawdust. The comparison is between a four foot circular saw cutting out a ⅜ inch kerf and a narrow band saw with a 3mm kerf. As previously discussed, see page 88, the kerf width is only one of the criteria to be thought about when choosing the type of saw to use. The other main efficiency issue is whether the saw rack is powered or manually pushed. This make a huge difference, especially as the afternoon draws on.

log handling

Manual handling always takes time and efficient handling of large logs is essential. In some cases taking the saw to the logs and setting the mill up around the log can be more efficient than bringing the log to the mill. This cuts out transporting large heavy logs, or a large volume of logs and the sawn material, being lighter, is much easier to handle.

experience of the sawyer

An experienced sawyer can make a major impact on how efficiently the timber is obtained – getting the first cut wrong can make a huge difference, especially when milling smaller diameter logs, as the position of the first cut can have a dramatic effect on the volume of sawn material obtained from each log and, of course, the volume of waste.

sharpening and maintenance

The sharpening of the various saws differ dramatically both in time and cost. I have listed below some of the basics. As always, care should be taken by using appropriate PPE and following the basic rule – when maintaining equipment always have the machine keys in your pocket.

tempered steel circular saw.

The teeth can be sharpened and set by hand. The edge can be touched up whilst the saw is still mounted in the machine (with all appropriate safety procedures, keys in your pocket!). To give it a good sharpen and set it is important to remove the blade but this generally takes only a few minutes. As the front and the top of each tooth is successively sharpened then the gullets need to be lowered to make sure the sawdust can clear easily. Over time this means that the blade gets gradually smaller in diameter, but only slowly. The equipment required is a selection of sharp hand files and a notched steel bar to set the teeth. See the saw sharpening video on *theinfoworks* Youtube channel (see *resources*, page 169).

tempered steel inserted tooth circular saw

With an inserted tooth circular saw the teeth can either be hand sharpened or replaced with new teeth. There is a short period of down time for this operation but the blade does not need to be removed for either of these operations. Each tooth is held in place by a snail cam that is put in place using the correct tool. There are several sizes of tooth and various widths to accommodate the width of the various sizes of blade. These teeth do not need setting as the cutting edge is part of a block in a similar way as that seen on a tungsten tipped circular saw blade. These teeth can be sharpened with a fine file, but only the gullet face is sharpened in a similar way as a chainsaw and the top of the tooth is not touched as this would reduce the size of the tooth block and is unnecessary.

standard carbide tipped circular saw

A tungsten carbide tipped standard circular saw blade will need to be removed and sent off to a saw sharpening company (saw doctors) to get it

fig 69: inserted tooth

sharpened but the blades on Peterson or Lucas mills can be sharpened on site with the correct sharpening equipment. Fig 70 shows a standard joinery circular saw blade and is included to show the tips. The tooth blocks again mean that no setting is required.

narrow band saw

Narrow band saws need specialist equipment to both sharpen and set the teeth. This is a time consuming process and the equipment required if you wish to buy it is expensive, although it does reduce down time when you are

fig 70: tungsten carbide tipped saw

milling. The bands do not last forever as cracks can start to develop from a point in the gullet just in front of the tooth. A tell tale sign of this is the band gently oscillating backwards and forwards rather than running smoothly.

general tooth profile

The profile of the saw teeth shown in figures 69 and 70 shows a chisel-like cutting edge that is set ninety degrees to the side of the blade or band. This is a ripping profile designed to be most efficient cutting down the grain (ripping). The tooth leans forward to make space in the gullet for the larger chippings that are created when ripping. The opposite of this is the cross-cut profile where the tooth makes an isosceles triangle with the cutting edge filed at an angle so as to create a sharp point. This profile makes even and small-particle sawdust and so the gullets do not need to be large; the gullet is that space immediately in front of the tooth. The number of teeth per inch (TPI) defines the size of the gullet and how many teeth are in the timber at any one point. The bigger the timber to be cut then the bigger teeth are required, which means a lower TPI, and if a saw squeals, particularly a band saw, that it is an indication of having too great a TPI (for the size of timber being cut) as there is insufficient space in the gullets to accommodate the sawdust generated.

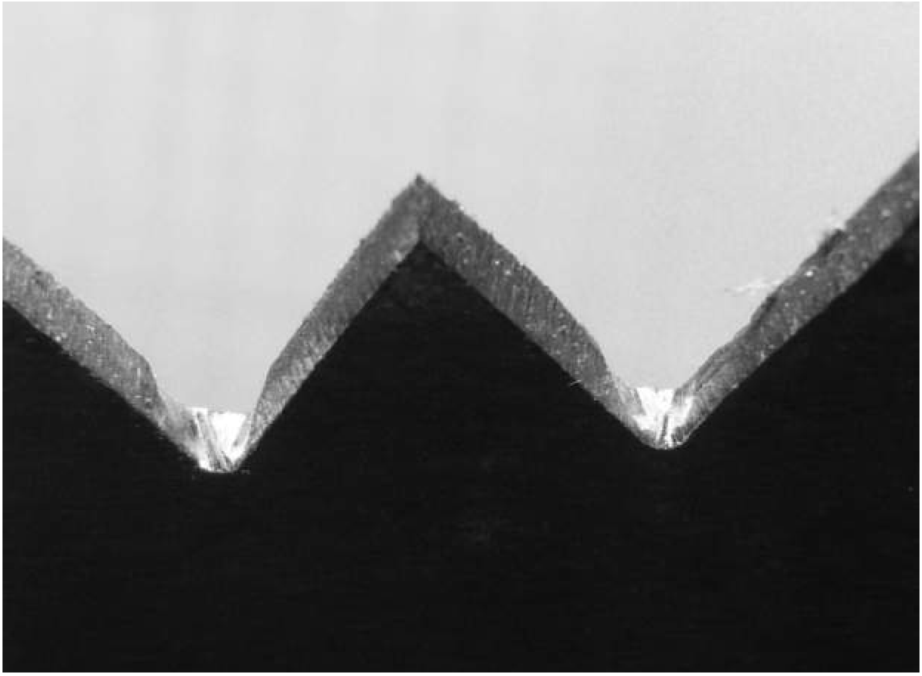


fig 71: cross cut tooth profile

For some tempered steel circular saw blades the profile is set half way between these two extremes, with the front of the tooth straight up, the back leaning forward, and a slight angle to the sharpening to create a point, rather than a chisel ripping edge.

tooth setting

With both the inserted tooth and the carbide tipped teeth the cutting edge is wider than the main body of the saw. This means that no setting is required. However with a tempered steel blade or band the teeth are formed out of the blade steel and so are the same thickness as the main saw body. If this blade were used without any set then the kerf would be the same width as the saw blade. This would produce friction from the timber rubbing on the saw and the sawdust being caught between the saw cut and the blade. The consequent build up of heat would make the blade distort. The correct way to prevent this is to set the teeth slightly to the side alternately, left, right, left, etc. This creates a kerf that is wider than the blade and so reduces this friction, reduces power consumption and improves accuracy. I use a piece of flat steel stock with a slot in it to set the teeth on my firewood saw. See fig 72 where a steel bar can be seen at an angle to the blade and the off set of the teeth is shown.

There two videos on the subject of sharpening and setting tempered steel blades on my Youtube channel (see *resources*, page 169).

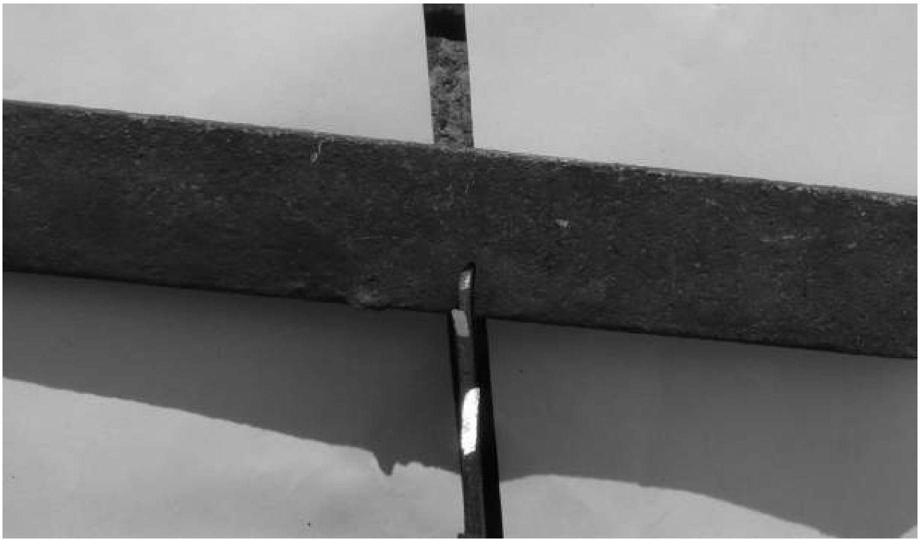


fig 72: tooth setting bar

how timber dries

wood structure

Wood is constructed from cells that are primarily made up of cellulose, a compound of hydrogen, carbon and oxygen. The majority of these cells form upright tubes and are called fibres in the timber trade. The following photos and drawings will give you a better understanding.

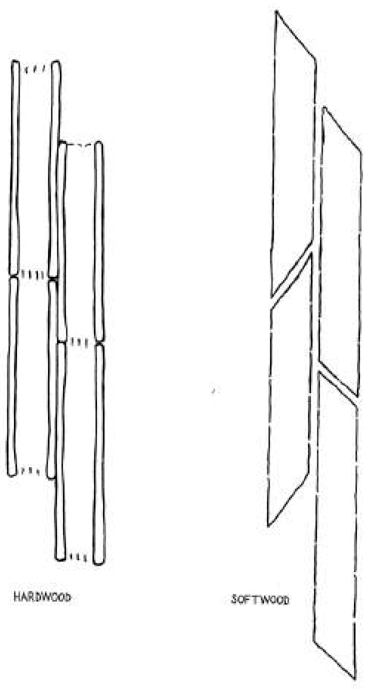


fig 73: hardwood and softwood cells

In hardwoods the tubes are stacked end on end and go all the way up the tree. In softwoods each tube is in the form of an extended lozenge (see fig 73). The purpose of these tubes is to distribute water and nutrients throughout the whole tree and they have little pores in their side walls to allow the passage of liquid sideways into a neighbouring tube (see fig 74). As you can see from fig 73, the hardwood cells have perforated ends, called sieve plates, through which the liquid flows. In the softwood cells the only flow is through the pores in the cell walls. When the living wood is freshly felled these cells are full of water and this water can be divided into two main types:

free water

The water that is lost when is air-dried. It is found within the cell enclosure.

bound water

Water that is found within the cellulose bonds in the cell walls. It is the loss of this water that makes timber shrink and is the bane of all carpenters' and joiners' lives. This is why timber shrinks across the grain much more than along the grain.

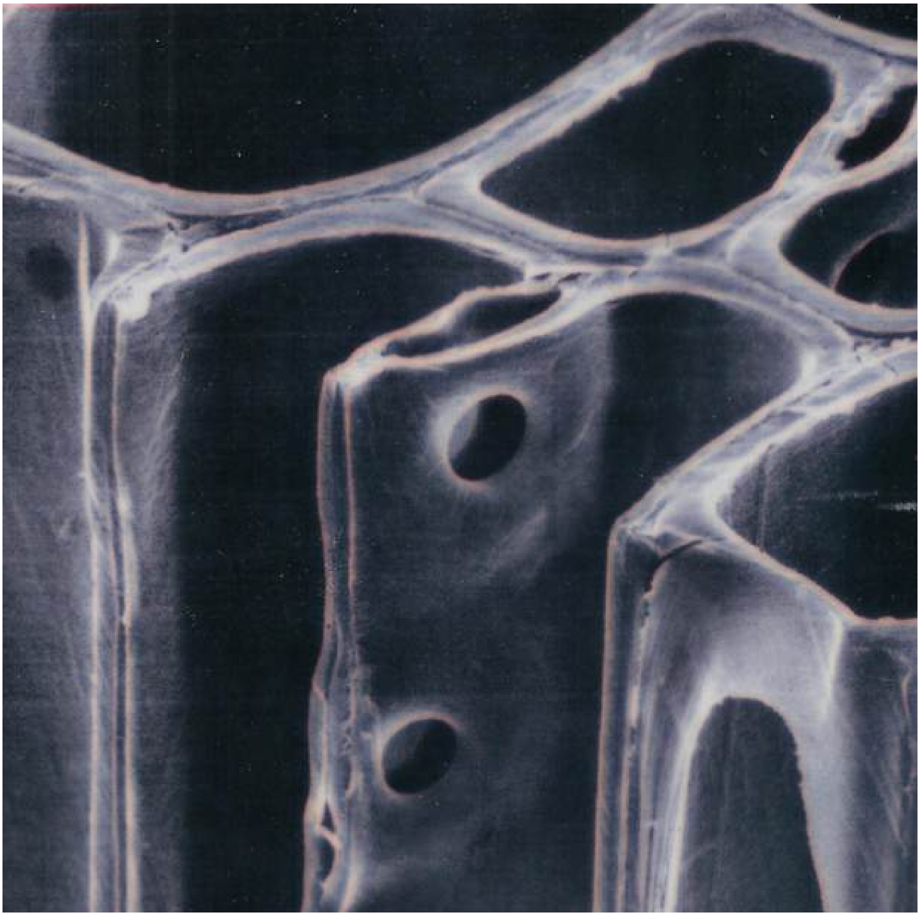


fig 74: cell structure

moisture content

The moisture content of wood sometimes confuses people and always causes discussion on the courses I have run in the past on building and wood-fuelled heating. There are several ways of determining moisture content but the commonest way is by using the 'oven dry' basis. The weight of the wood is taken before it is dried gently in an oven, so explaining the term 'oven dry' basis. The oven-dried weight is then subtracted from the original weight to give the weight of the water lost. The weight of water is then divided by the weight of oven-dried wood, and the answer is multiplied by one hundred to give the percentage. Should the weight of the water and wood be equal then the answer is a hundred per cent. This explains why you get some timbers with a hundred per cent moisture content when they are freshly felled, for example Norway spruce or poplar. I did a simple experiment on a small selection of different types of wood by weighing a freshly-felled sample of each then leaving it in the warming oven of my kitchen range for a week, and then I weighed it again. The examples were quite small and split to about half an inch thick so that all the moisture could move out from the centre.

The movement of water from the centre of the piece of wood is an important issue with drying timber – you must not allow the outside to become too dry otherwise you get a situation where the moisture in the centre of a board cannot move through the very dry external cells and so any further drying is prevented. It is called 'case hardening' and the only way to remedy this fault is to soak the boards with water. This is one of many potential drying faults and they are covered in detail in *the drying process*, page 131. There are two videos covering moisture content measurement using oven dried method on my Youtube channel, see *resources* page 169.

My results are shown in fig 75 overleaf. Many of the moisture meters on the market are not very accurate at higher percentages but this doesn't matter because the important part of the drying process is at or below the fibre saturation point. This is the point where the water within the cell enclosure has gone but that within the cell walls is still intact, hence fibre saturation; care is needed beyond this point in the drying cycle.

cell structure and drying

The cell structure of timber affects the way wood dries. The photo showing cell structure (see fig 74) shows pores in the cell walls. These pores occur in both hardwood and softwoods but the softwoods have a valve in the

	Ash	Sycamore	Beech	Poplar	Western Red Cedar	Norway Spruce
Green Weight (oz)	12.5	12.5	13.75	12.75	11.75	13
Oven Dried Weight (oz)	9	8	8.5	6.5	5	5
Weight of water (oz)	3.5	4.5	5.25	6.25	6.75	8
Moisture content (Green weight)	28%	36%	38%	49%	57%	61%
Fibre Water Ratio	2.6:1	1.8:1	1.6:1	1.04:1	0.75:1	0.62:1
Ideal Fuel Moisture Content (oven dried)	Less than 25%	Less than 25%	Less than 25%	Less than 25%	Less than 25%	Less than 25%
Percentage Moisture Content (oven dried)	39%	56%	62%	96%	135%	160%

fig 75: comparison of the moisture content of green and oven-dried timber

pore that closes if air gets into the cell on one side. The valve is called a torus and is held in place by fine filaments. This is a defence mechanism to prevent fungus and bacteria from entering the tree when it is damaged. It has the extra effect of reducing water loss and increasing drying times in cut timber. Different timbers have distinct properties that affect drying and relate to the way that moisture will move through the timber.

ring porous timber

This kind of timber only allows movement of water along the annual rings, which means the water can only escape from the ends of the annual rings on the cut surfaces. Examples: oak and sweet chestnut.

diffuse porous timber

This kind of timber will dry both across and along the annual rings, which allows the timber to dry much more quickly and evenly than ring porous timber. Examples: willow and poplar.

semi-diffuse porous timber

This is ring porous timber with a small amount of porosity across the annual rings, it dries quicker than ring porous timber. Examples: cherry and birch.

the drying process

log storage

When using a mobile sawmill more often than not the logs are converted on site so that the practical problems of lifting and moving large logs can be avoided, however you may find yourself in the situation where you wish to store some logs for a while. This is not a desirable situation to be in but this short section may help you to avoid some of the problems. It is better to convert the logs though, and if you are unsure of the sizes you may require then mill them into the largest practical size so that they can be resawn later. Make sure that you cut out the actual centre point of the tree (the pith) as this will be where shake and movement works from or to.

I remember driving through the Black Forest late last century and the small sawmills I saw all had water sprinklers on their softwood log stacks. This was to keep the timber wet and prevent the blue staining I described on page 56. This highlights one of the problems of storing logs for any length of time. The problems incurred can come from several sources including insect attack, fungus, or faults caused by drying out.

insect attack

There are all sorts of wood boring insects willing to have a go at your timber before and after it has been milled. These include the various wood worms and beetle larvae, plus such things as the greater wood wasp whose grubs bore tunnels up to 10mm in diameter and favour the softwoods like larch and the pines.

fungal attack

The attack on the cell walls of timber by fungus is the start of the whole process of breaking down of woody material to return the minerals and nutrients back to the soil. This is an important part of woodland ecology but all in its correct place and not in timber you wish to convert. This means you have to know which timbers will show damage early and which will give you some time.

Birch, sycamore and beech quickly show signs of spalting, which is staining of the timber by the action of fungi. Some softwoods like Scots and Corsican pines show the effects of blue stain fungus after only three months in warm humid conditions. All these should be converted quickly to get the drying process started as early as possible. Other timbers like oak, sweet chestnut, Douglas fir, European larch, western red cedar, Monterey cypress and even Norway spruce are more resistant but there are other problems caused by keeping the timber in the round.

drying

In the *logs and round wood* chapter there is a section devoted to shake, page 49. This is all to do with the drying of wood cells in the heartwood whilst the tree is still growing. Well the drying of logs in the round can cause a diametrically opposite form of shake where the outside of the logs dries whilst the inside is still wet. So the outer cells shrink and the inner ones do not, and the outcome is that the inside is then too big for the shrunken outside so shakes appear where the stress is relieved by large cracks running along the length of the log. This then reduces your options when milling because you do not want these shakes in any of the milled timber as it interferes with the strength of timbers or makes joinery impossible. The shake is most often found at the point where the heart is closest to the outside of the log. We used this factor when teaching chainsaw carving, so when (say) creating an Easter Island head then the heart should be closer to the back of the piece than the front to avoid a nasty timber shake up the face.

If you wish to store logs there are several options but these are only open to certain species, from which sycamore, beech and birch are excluded due to their tendency to rapid fungal infection. The major consideration is to keep the logs off the ground on bearers but also to avoid the drying effects of direct sunlight, so keep them in cool shade. There is the option of ‘ponding’, where the logs can be immersed in water. This slowly dilutes the sap whilst keeping the logs wet and prevents invasion by wood destroying fungus; it is, however, quite fundamentalist. Just as a side issue here to prove the point, when logs were extracted from the woods by horses in America, the logs were then driven down to the mills in the rivers as the snow melt gave high water; a process know as the river drive. Some of these logs were trapped and remained at the bottom of the rivers for many years and these are now being salvaged and prove to be really good quality timber even after all that time. There is a chapter about the river drive in *Tall Trees, Tough Men* by Robert Pike, see *resources*, page 169.

fig 76: drying shake in a red cedar log

using timber green

There are many situations where timber can be used straight from the saw and others where some degree of drying is required.

To use timber green ensure the final use allows for the inevitable shrinking and movement as it dries, or it maybe that the movement doesn't matter, as would be the case with fence rails, gate posts, etc. The weather boarding shown in fig 66, page 110, was used green but the method of nailing allowed each board to expand or contract without exerting any tension within the board. There is only one nail per board in each framework stud. This misses the top of the board below (and underneath) but clamps it in place, and the next board clamps the top, but because it is only clamped (but not nailed) free movement is possible across the board. Just a tip here, make a point of only using galvanised wire nails, so you don't get horrible rust spots at regular intervals on the boards. In the photo the boards are one inch thick, so the nail goes through a board, then the gap above the lower board then two inches into the stud, hence four inch nails are used.

An example of using green timber in the wrong place can be taken from the following tale of inexperience and woe. Back in the late eighties there was a point where the building trade was booming and the value of the pound was high. This meant that there was a demand for timber and imported timber was expensive. An ideal situation for local timber growers, but such was the demand that certain builders' merchants were selling fresh-sawn green timber for house construction. I have known certain loft conversions where fresh sawn Corsican pine was used and then within a week it was covered with plasterboard and skimmed with plaster. I think we all now know what happens to green pine when in a warm moist environment. The blue stain actually came through the plasterboard and plaster. And so we move on to air-drying.

air drying

If you have the time air-drying is almost free and, in the right conditions, produces a very nice product. Of course the product is only as good as the timber will allow which includes knot frequency, spiral grain, shake and damage. The quality of the milling is another factor in that if the heart centre is included in a board then this will degrade the board as it dries. Further to this the timber should be milled parallel to the centre of the tree so that the grain runs along the board and does not run off from one face of the timber to the other as shown in fig 13, page 31.

To allow timber to air dry properly you cannot rush it and shake and case hardening must be avoided. So the timber must be in a well-ventilated and shaded area. In *The Village Carpenter* by Walter Rose he talks not only of itinerant sawyers travelling with their own pit saw, but of the timber stacks in the log yard protected under the canopy of a huge and spreading walnut tree.

fig 77: weatherboard nailing

On several occasions I bought some timber from the sawmill at Bagley Wood near Oxford. Their sawn material was stored in traditional drying sheds. These being mono-pitch, tin-roofed sheds with good guttering and open boarded sides providing good ventilation with the open front facing north to avoid direct sunlight. Inside was fitted out with solid bearers set at close and regular intervals to keep the timber well supported and providing a gap of at least a foot below the bottom of each timber stack.

So, what general considerations are required for good air-drying? Here are a few general rules:

- out of direct sunlight and quite cool to prevent excess and quick drying

- well supported on solid level bearers to keep the timber straight
- well ventilated to encourage drying and prevent mould and fungal staining

As an example of pragmatic air drying I will describe how I did it when I was making stairs. I used to air dry my timber before putting it through the kiln-drying process of which we will talk later. There was a partially shaded area on the north side of the workshop, which was the best I could do at the time. Old sets of straight-flight staircases that had been replaced were used (laid flat) as a base on which to build the timber stack.

Now, an important thing here is to trick the end of the boards into thinking that they are not the end. If a cut end is exposed it will dry much quicker than the middle of the board, and we all know what happens to timber if there is a high moisture gradient – it splits. So I became an inveterate collector of old part-used tins of paint thrown in skips. I used to mix it all together and paint the ends of the boards to prevent any moisture escaping through the end grain of the cut board end. This prevents the drying shakes that can lose you a foot on the end of each board.

For air drying it is important to have a small air gap around each board and so every board on each layer of a stack must have a gap of at least an inch between it and its neighbour, but not too much. For the twelve inch boards I preferred, each stack would have two boards per layer; that way each board had the same drying conditions. If there were three boards per layer then the centre board would be under different and slower drying conditions.

So 3 x 3 inch bearers were laid across the old staircase bases at about fourteen inches apart to provide solid support for the stack. This then set out the distance between all the other drying spacers that I called stickers. The first two boards were laid down making sure the bearers were evenly spaced and preventing overhung and unsupported ends, and making sure there was an even gap between the two boards.

The stickers I used were tile lats that are usually used when attaching tiles on to roofs and were 1½ x 1 inch and, because they were treated, lasted for years. Having placed the first stack layer then another set of stickers was placed above each bearer to take the next layer.


fig 78: stack with stickers

The next boards were put in position and then the next series of stickers, making sure the stickers were in line with those below. This prevents any chance of the boards being bent due to the weight of the stack above, as the weight is neatly transferred down through to the bearers. Continue to build the stack until either your boards are used up, or the stack would be unstable if you built it higher. The top boards are now exposed and so would dry unevenly, so another set of stickers is required followed by some other material to simulate another layer of boards. This is necessary for even drying in the top layer, I used old kitchen worktop. On top of this goes something waterproof like corrugated roof sheets, and then some weight is piled on the top; old tyres, engine blocks, concrete slabs, anything you have. This reduces the warping and movement in the boards, especially in the upper layers of the stack where there is less weight above. So again you become a collector not only of old paint but of heavy things that no one else would walk off with. When the stack is complete with all its stickers the term used to describe the stack is ‘in stick’.

fig 79: timber stack

I can hear certain people questioning the time taken for air drying and to some extent this is the product of the industrial age and the modern ‘I want it now culture’, but once I have it there is no real value and so on to the next ‘I want it now’ until all resources are consumed, then there will be tears and regret. Time is weird stuff and it is only relative to engagement and the time available. For a child a wet Tuesday afternoon is about a decade long, but for active, late-middle-aged people looking back in mid August then the previous January was about last Thursday. If you don’t know what I am talking about then you must be young and I credit you for your patience in having read this far. Jerome K Jerome has much to say about time in several of his books, namely *Idle Thoughts of an Idle Fellow* and *Three Men in a Boat*. In the latter there is a passage about getting a kettle to boil in a boat, and if watched then the boil will never occur. The correct method apparently is to set the kettle on the burner and then talk loudly about not wanting any tea and preferring lemonade, at which point the kettle boils and puts out the burner. The point here (I think) is that both time and attention are flexible and I am sure that nuclear physicists would have plenty to say but perhaps their meaning would escape us.

There is a connection to what we assume was a slower and simpler way of life by air-drying timber. There is a kind of Zen thing going on where the expectations of modern life are relaxed and drying this way is a way of laying down timber without immediate expectations; it will be ready next year when I get round to doing that project. However if you are on a mission where there are timescales, then start early and, if needs be, partly air dry and finish off in a kiln. And so on to kiln drying.

kiln drying

There are many different types of kilns for drying timber and they are primarily divided into either 'heat and vent' or dehumidifier, and the names describe the method of moisture removal.

The heat and vent does what it says; gently heating the kiln contents up to make the moisture move out into the air through the timber and then venting some of the high moisture content air. The general idea is to encourage moisture from the centre of a board to migrate through the layers of cells to the outside of the board and hence to evaporate, but without 'case hardening' the outside layers (over drying) as we have covered earlier, page 127. The air inside the kiln is not dry, but over the duration of the drying process the moisture content is gradually reduced as the timber dries.

When I was drying wood for making staircases I used a dehumidifier kiln and I had the good fortune to borrow a chart-recording humidity meter. Over a three week drying cycle it showed the humidity within the kiln gradually reducing. It wasn't a straight line chart but the reading did not wander very far. To make sure all the timber dries evenly throughout the stack then air circulation fans are needed. This prevents areas of dead air that would be ideal for fungal growth like mould and blue stain and, of course, causing uneven drying and high moisture gradients within boards.

The method of heating can be quite carbon intensive, like oil or electricity, or more planet friendly as in solar or as part of a combined heat and power system or just simply added on to a biomass heating system. As with all systems it is the control of both temperature and moisture content that are critical, and installing a series of sensors feeding to a microprocessor makes fine control possible. The controls are preset to a drying schedule with either settings recommended by the manufacturer or with modified ones built up from experience. Factors you learn to take into account include the volume of timber, thickness of boards, temperature, the moisture content of the timber and of the air in the kiln, duration and point through the cycle and required finished moisture content. The thicker the boards then the longer the cycle has to be as there is less surface area within the stack through which moisture is lost. A 12 x 3 inch board twelve feet long has thirty square feet of surface area, whereas an equal volume of one inch boards (three boards) has seventy-eight square feet.

I took a morning out to go up the east coast a few miles to Wazel Wood Floors to see the loading of their heat and vent kiln.

fig 80: loading a kiln

Fig 80 shows an end-loading heat and vent kiln, where the stacks are mounted on low-slung wheeled bogies that enable mechanical handling of the timber. It also means that once the packs of sawn timber are set out in stick then there is no further manual handling to be done.

The rail-type tracks are seen in fig 81 where a baffle is being put in position prior to closing the large insulated doors.

The stack still requires the use of stickers between the layers and the orientation of the stickers is essential so that air circulation between the layers is not impeded. In the case of the kiln in fig 80 the packs of timber are set out with the stickers running sideways. This works in with the way the packs are loaded and the fans blow the air sideways through the stacks. As the stacks are loaded moisture probes are hammered into predrilled holes in the timber and then signal wires are attached.

Fig 82 shows the probes with the signal wires are attached. These give a constant reading and the probes must be deep enough to reach the centre of the board. This can then give a true reading rather than a surface reading. On starting this kiln up gentle heat is applied and water is sprayed

fig 81: closing the kiln doors

through fine nozzles to increase the ambient moisture content within the kiln. This gives a good start to the process, speeds things up and prevents any surface checking.

The size of the load must match the capacity of the kiln. It stands to reason that you cannot overfill a kiln, but drying too small a quantity will be inefficient and can cause poor-drying faults. Of all these types of heat and vent kilns it is the solar kiln that is most likely to be built by the back yard constructor but in the UK its use would be restricted by the seasons.

fig 82: moisture probe wiring

the dehumidifier kiln

Dehumidifier kilns run at a lower temperature than the heat and vent kind, can be more energy efficient and, when set correctly, have a less aggressive effect on the timber. Heat is not vented as part of the drying and the heat created by the dehumidifier compressor remains in the kiln and contributes to the maintenance of the temperature. The dehumidifier unit is mounted within the kiln so that air is drawn through it as part of the general air circulation needed for even drying.

A dehumidifier works on the same principle as a fridge where an electrically-powered compressor pressurises a gas, which when released through a nozzle has a cooling effect. This is the Jules effect and can be seen when propane bottled gas is used in winter and frost forms on the top part of the bottle and the regulator. A gas under pressure when released creates cooling. So the idea of a dehumidifier kiln is that the circulated air is forced around a specific pathway and in this way the moisture-rich air that has passed between the boards is then directed through the dehumidifier with no way of bypassing the unit. Within the unit there is a compressor and a series of cold coils on which the moisture condenses. This then collects in a tray and is drained away to the outside of the kiln. Creating cold is just taking the heat out of something and so there needs to be a way of dumping that heat. On a fridge there is often a type of air-cooled radiator on the back to lose this heat but within a kiln it is beneficial to retain this heat within the enclosure. To this end there is another set of coils that get hot. The way these parts are set out helps with efficient running. The moisture-rich warm air is drawn into the unit and over the cold coils by a large fan and the moisture condenses on the cold surfaces. The cooled air then passes over the compressor to keep it cool and then as it passes over the hot coils removes further heat to allow cooled gas to return to the compressor.

In some kilns there is also a thermostatically-controlled, small-wattage electrical heater behind the hot coils. This is used in the initial stage of the drying cycle to build up heat. A schedule is required to control the speed and hence quality of the drying. This will initially come from the manual for the dehumidifier unit, but as experience is built up it is common to modify these settings to suit your own homemade kiln enclosure. The schedule defines the on and off periods of the compressor; so for a stack of one inch boards the settings may be forty-five minutes on and fifteen minutes off. If thicker timber is being dried, as it has less surface area the compressor needs to run less and so the settings may be fifteen minutes on forty-five minutes off. During the off time the fans continue to run to help build up the moisture in the air again. The important thing is to prevent drying the air completely as this will create case hardening and shake. With the Arrowsmith Junior unit I used, there were two power cables, one for the heater and fan circuit and one for the compressor. The latter was fed through a multi-setting time switch to set the on/off schedule.

So it is important that all the air within the well-insulated kiln structure is forced to go through the drying unit and it is equally important that this same air must be blown through the stack and not allowed to bypass either of these. A description and a diagram are required to get the concept across. The kiln box could be something like four feet deep, six feet high, and twelve feet long. The timber is loaded from the longest side so this side has removable panels. The drying unit is mounted in the centre at the top of the back of the box and the power cables and water drain go out through the back wall. Either side of the drying unit is a false wall extending from the top of the box, the full width, and the same height as the unit. This creates a short false wall that the Arrowsmith company called a drop beam.

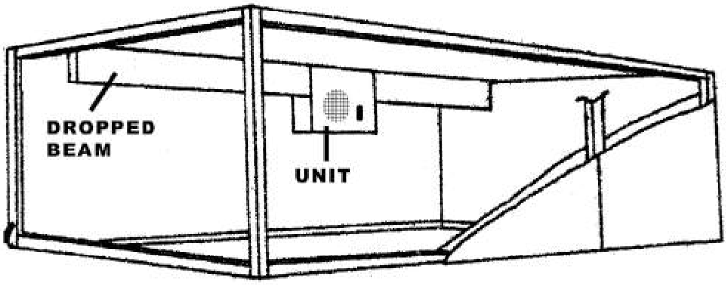


fig 83: dehumidifier kiln

A polythene sheet is hung from this drop beam and the kiln unit and when the kiln is loaded this sheet is fixed to the top of the stack. The idea is that the unit fan blows the air from the unit, which then draws further air from behind the drop beam. The air is blown forward and, because the box is sealed, the only place for the air to go is down the front of the stack and between the boards and so to the back of the stack. From there the air is drawn back into the unit and so the cycle is complete, and a small volume of water removed.

loading a dehumidifier kiln

Firstly a set of bearers is needed to support the timber in exactly the same way as described in the *air drying* section, page 134. These need to have a solid support underneath so that the subsequent stack remains flat and even. The bearers must be larger than the stickers; about three inches is good. All the bearers and stickers must be in line with the airflow direction, so they are laid from the front opening to the rear wall. If they were laid the other way they would block the airflow and seriously affect the drying. The bearers are set out as for air drying at about eighteen inches apart, but if very thin timber is being dried then this distance should be reduced to provide ample support. The first layer of boards is loaded with a gap of at least six inches clear at the back and at the front for good air flow from and to the stack. The boards in each layer should be butted up tight to prevent cross flow from one layer to another which could create possible areas of reduced air flow and hence reduced drying and moisture gradients.

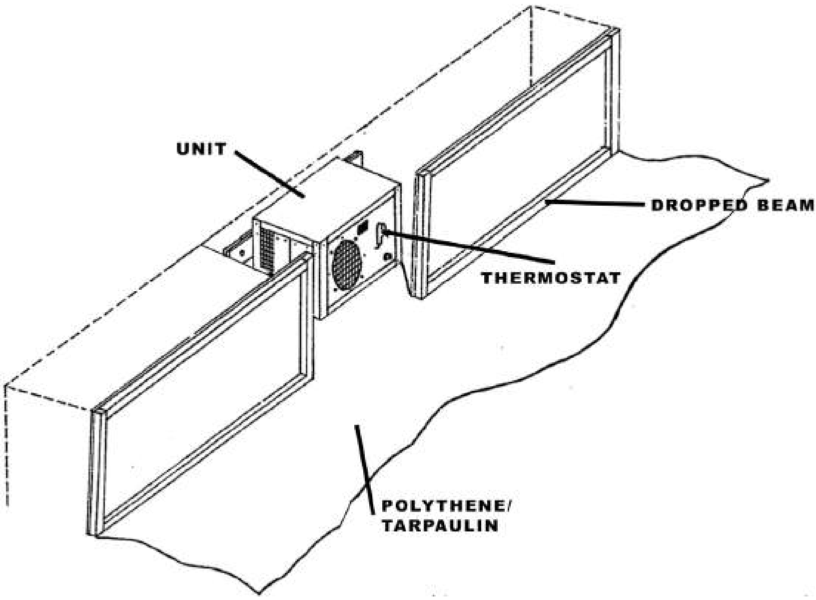


fig 84: kiln drop beam

Lay the stickers on top of the first layer directly above the bearers and then load the next layer of boards. I always used to butt one end of the stack against an end wall of the kiln to prevent air flow around the stack at that end; the other end will need to be blocked off before closing the kiln.

The stack is built up making sure the both the front and back faces are even and vertical to help with smooth air flow. The finished stack must not be higher than the fan level; so having completed the loading of boards for drying the stack is finished off just the same as air drying with a dummy top layer. The polythene drop sheet from the drop beam then covers the top of the dummy layer but does not go down the front. Weights can be added if required, but again they must not impede the airflow. It is normal for the stack to be shorter than the width of the kiln enclosure, so one end butts up to an end wall and the other end needs to be closed off to force the circulating air through the stack, hence preventing bypass. I did this with an old sheet of polythene that was reused each time. It was fixed in place to the end wall and the end of the stack using a staple gun, with the drop sheet overlapping and sealed with parcel tape. When I used the Arrowsmith unit I would set the thermostat at thirty degrees and then fix the side doors in place. It is important to get as good a seal as possible to prevent heat loss and as my kiln box got older I found it necessary to use builders' gapfilling foam (urethane) to seal the gaps. This made a huge difference in drying efficiency, heat retention and electricity consumption. The compressor schedule timer was then adjusted to suit the volume of timber and the thickness of the boards and the unit was switched on. The temperature gradually built up over the next few days, as did the water output, which drained into a bucket so that this could be monitored. A steady day-on-day water output was required that tapered off gradually towards the expected finishing date. Any sudden loss of output would need investigating and could mean blown fuses, failure of the unit, or the fan or drying too quickly leading to case hardening.

making your own dehumidifier kiln

It will be evident from reading this chapter that it is well within the bounds of practicability to construct a kiln box. All it needs is to be airtight and well insulated. With the dehumidifier type an end loading enclosure is not practical as the drop sheet needs to be fitted and the anti bypass sheets need to be stapled in place. To this end side loading is necessary and this leads to its own problems, which includes the structural element of removing a whole side of the kiln and the need to keep these removable side panels air tight. I made my kiln from a composite material of 9mm ply with 50mm of urethane foam bonded to it and then with a foil finish. How you make it is up to your own ingenuity as long as it is practical to use and does not waste energy. Reclaimed materials are always a good start. On the various timber-building courses that I have run there has been heated discussion on the type of insulation material that is ethically acceptable. My line is that a great deal of modern insulation is not recycled when buildings and cold stores are demolished. If you reuse this that is great as it avoids landfill and if it costs you nothing then that is a double benefit.

It is helpful to have your kiln box within another building so that you do not have to build weatherproofing into the structure. The main criterion here is easy access for the load / unload cycles. I used a lean-to on the back of the workshop. I tried not to run the kiln in winter because of the extra energy required to keep the heat up. This is because the loss of heat is dependent on the difference in temperature between inside and outside. The U value of a building is rated as the loss of heat in watts through the structure per degree of temperature difference; so more heat is lost as this difference increases. You could make a phenomenally well-insulated box, and a cost benefit analysis could be done but there is a point where it is simply easier not to use the kiln in the depths of winter. It just means you have to be organised and brings us back to the time issue that was discussed earlier.

For the dehumidifier part of a homemade kiln you could use a second-hand domestic or industrial unit. A direct electrical feed to the fan would keep it running when the timer switches the rest of the unit off. It is important to mount the unit to prevent air bypass as discussed earlier and a hose connection is needed to drain the water to the outside collection and monitoring bucket. These standard dehumidifiers are not designed to run at high temperature and so the kiln would have to be run at a comparatively low temperature (25ºC) and so would take longer to dry your timber. Here again there needs to be a cost benefit analysis of time over investment, so it depends on how much timber you wish to dry and where the time goes. If this is unsuitable then commercial units are available to fit in your own box.

drying faults

Regulating the speed of drying is important for both air and kiln drying to reduce or totally remove the development of faults. Knots and other timber faults that exist within the timber will always cause problems but careful drying will reduce effects of these.

air drying faults

unpainted ends

This will cause shake from the end of the board and the loss in quality of at least six inches on each end of the piece.

direct hot sunlight

Will cause the outside of the timber to dry quickly and cause checking of the surface and shake and warping in severe situations.

damp conditions

Damp conditions will naturally slow drying down but with certain species it will encourage mould and fungal infection. Sycamore will change from white to light grey; some pines will quickly go blue in warm wet conditions. I have used Corsican pine boards that had some blue flecks from the fungus. It's all very well if the work is to be painted, otherwise a feature must be made of it. The blue stops as soon as the moisture content is low.

warping

This can be caused by an unstable stack, uneven stack base, insufficient stickers (so that they are too far apart) or drying too quickly. Having said that, if you are drying poor quality timber with knots and uneven grain then you will always get faults, warping, or winding (twist). The skill is in reducing the effects and as I have covered earlier some trees quite often have spiral grain (sweet chestnut and Corsican pine).

kiln drying faults

Many of the faults listed under air drying also can be seen when a kiln is used.

quick drying

Drying too quickly will cause surface checking and shake but can also cause case hardening. The solution to this is to open the kiln and get the hosepipe out to soak the timber. Following this, close the kiln and just leave the fans running for a couple of days, then start the compressor again once the timber has soaked up all the water. Make sure to adjust your schedule timings so as to dry at a much slower rate

mould and fungus

It is in the nature of a kiln to keep a warm wet environment so timbers that are susceptible to staining can be treated with solutions of borax prior to loading to reduce the chance of mould taking hold.

over drying

One can, if you are the forgetful type, leave a kiln running for too long and dry the timber below eight per cent. Some timbers have a tendency for the cells to collapse and cause depressed areas on the board surface. I once tried some southern beech (*Nothafagus*) and this happened at about ten per cent, it also seemed to have a tendency to move and shake even with a steady drying schedule.

desired moisture content

The moisture content you need is dependent on the final use of the timber and the environment into which it is installed. We have already covered using green or freshly sawn timber, and seen that there are stages of moisture content suitable for different situations. I use air-dried timber for window frames due to the fact that a good proportion of the timber is exterior. When building the Ecolodge I used some home kiln-dried Douglas fir left over from the stair making days for a few of the windows. This was fine but after a few months I then had to refit the casements as they has expanded and tightened up in the frames. So I now use well air-dried timber for this type of work with a moisture content of about sixteen per cent (dry weight). An explanation of both dry and wet weight moisture content follows at the end of this section.

The moisture content of timber used for internal work needs to be lower than for external work. I made the front door of our cottage from air-dried red cedar but there is a porch out front. The lower door panel made from three 165 x 40mm boards shrank, losing 3mm width on each board. This is why joinery is constructed to allow for movement, the panels being held in place with loose tongues in grooves

Floor and skirting boards are the worst as they are very visible and so for internal work within centrally heated buildings moisture content of about eight per cent (dry weight) is desirable. The Wazel Wood Floor Company recommend that flooring material should be naturalised within the building for several weeks before laying to try to avoid movement once an expensive and decorative floor has been laid. This, of course, does not help when recent large building works have taken place or on a new build where the moisture content of the building structure is changing.

measuring moisture content

In *how timber dries*, page 125, I talked about the oven-dried method of moisture content calculation. This is all well and fine if perhaps you are dealing with wood chip for boilers and similar large volume enterprises but it is not so practical for small-scale timber construction and joinery works. Hence the use of a moisture meter makes these checks quick and easy.

There are several things to know about using about these very handy instruments; make sure the battery is in good condition, use with the points across the grain and the spikes should be pushed into the timber to their full length – there is no point just measuring at the surface. With large timber sizes the plug-in, drive-in spikes are required to get a reading from further into the timber. These use a slide hammer to drive and remove the spikes from the board. There is an adjustment to the reading required when measuring timber in a kiln to account for the temperature. This factor will be given in the meter's handbook. The meter shown in fig 85 is perhaps twenty years old and is based on dry weight. The scale can go above one hundred per cent and so this means that at that reading the weight of water in the timber is equal to the weight of the timber itself. There are other meters that work on a wet basis and so in this example would show fifty per cent. That means that half of the weight is wood and half water, just the same but taken from a different perspective. The conversion factor between the two methods being 1:2.

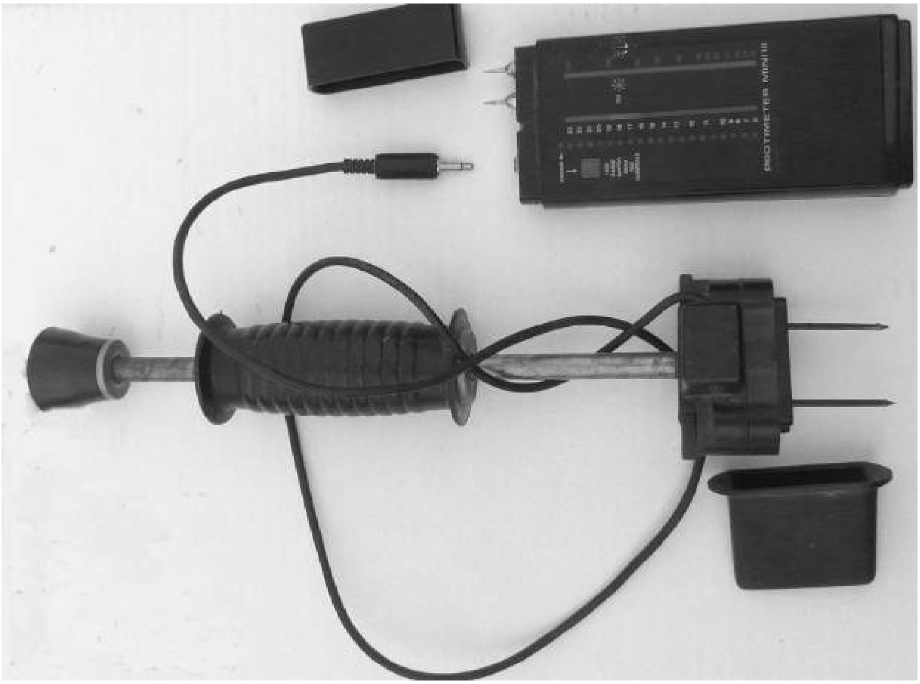


fig 85: moisture meter and hammer probe

dry timber storage.

The trick here is to have a good dry shed with a damp-proof membrane in the floor, a good roof with ample gutters and drainage, well sealed doors and no broken windows.

Given half a chance the timber will absorb any moisture that is available, so don’t give it a chance. It no longer has to be kept in stick once it has either air-or kiln-dried. This means it takes up less space, but it must be ventilated under the stack, so bearers are vitally important.

transport

Depending on where the timber is stacked or laid out you will need to move it either before or after milling. It is common for trees that have been felled within a woodland to be extracted by machinery or horse power to a place where the access for road transport is easy – or at least possible. The trees can be either cut up to a standard length (say three metres) and stacked – this is seen most often with conifer – or for larger trees, and especially hardwoods, the main stem is trimmed off near the top and left in the full length (known as whole pole), in which case they will be laid out side by side butt end to the track or ride. These whole poles are then extracted by winch or skidder, see fig 86 which shows a skidder working the beech woods of the Chilterns.

fig 86: skidder extracting whole poles

The whole pole logs are commonly numbered and the volume of each log measured ready for sale. Where a single tree is felled or blown over then the tree lays where it fell and it is impracticable to extract it due to the logistics of moving machinery and people on site for just one log. The beauty of mobile sawmills is that you can easily get them on site and mill a single log and hence reduce any transport problems, as it is much easier to move many small pieces than several large logs (by which I mean whole tree trunks). This, however, is not always possible.

fig 87: mixed hardwood log stack

fig 88: whole poles numbered and laid out

If you need to move a large log or a stack then the choices for transporting them vary depending on weight, volume and the distance needed to travel. If you have (say) twenty tons to move and you cannot mill it on site then the service of a timber haulier is the obvious solution. These hauliers can load and unload with a trailer-mounted crane so all the effort and time is reduced. It is important however for the lorry to be able to get to the logs. The access may be weather dependant, or the stack may be in a really silly place (not as uncommon as you would think). The other side of this is the delivery, where you want it stacked, and can the lorry get in there? And what's more can it get out again? You have to remember that once a lorry has lost the weight of the load it has less traction and so is more prone to wheel spin and getting stuck. Guess who gets shouted at then?

fig 89: timber haulier unloading

If however there is just a small parcel of two tons or one large log then a trailer behind a suitable vehicle will work but the loading and unloading can take time and effort. The trailer laws in the UK have tightened up considerablely in the last few years, and I hear that they won't let you build you own trailer anymore, so if you have one it's an old one that you have rebuilt.

If you are below a certain age you also have to have a trailer licence if the trailed weight is above 750kg. It's all part of the system to stop self-reliance and so we are beholden to industry to provide; teaching the population a learned helplessness and so they will believe any old nonsense due to the lack of having any practical experience.

When moving timber any distance there is always the temptation to load those last few pieces to avoid another journey, and it will be fine won't it? It is a pain to have a tyre blow out because of overloading, and maybe the tyre was a bit old and you really should have changed it last year but, what with the cost and time, it was one of those jobs that never happened. Then you are by the side of the road at the mercy of the next police car. The important thing is to always carry a spare wheel with jack and brace; then at least you can get moving quickly, and of course resist the temptation to overload in the first place, but I'm a right one to preach.

I include a photo here showing an example of trailer overloading (because it was a rare opportunity to move such a log) that years ago you could get away with but perhaps now would lead you into problems.

fig 90: overloaded trailer

timber preparation

fig 91: jack plane

hand preparation

During my joinery training I was taught to prepare timber from the sawn stock by hand, and I have included this section as it is a useful skill to have when there is a need to prepare a piece of timber and no machine tools are available. When renovating my cottage in the latter part of the last century there was the need to plane up and square a beam 7 x 7 inches in section and fifteen feet long. I did this by hand using the techniques described below, and then added some stopped chamfers cut using a marking gauge and an inch chisel. A chamfer is where the corner of a section (in this case timber, but it is also seen in stone and other materials) is removed for decoration but to prevent complications where pieces of timber meet the chamfer is stopped before the joint, hence a stopped chafer, see fig 92.

fig 92: stopped chamfer

During my training the preparation involved ripping boards along the grain by hand. I actually re-profiled the teeth on a 4 TPI handsaw from dual-purpose shape to true ripping. This involved some considerable effort with a three-cornered saw file.

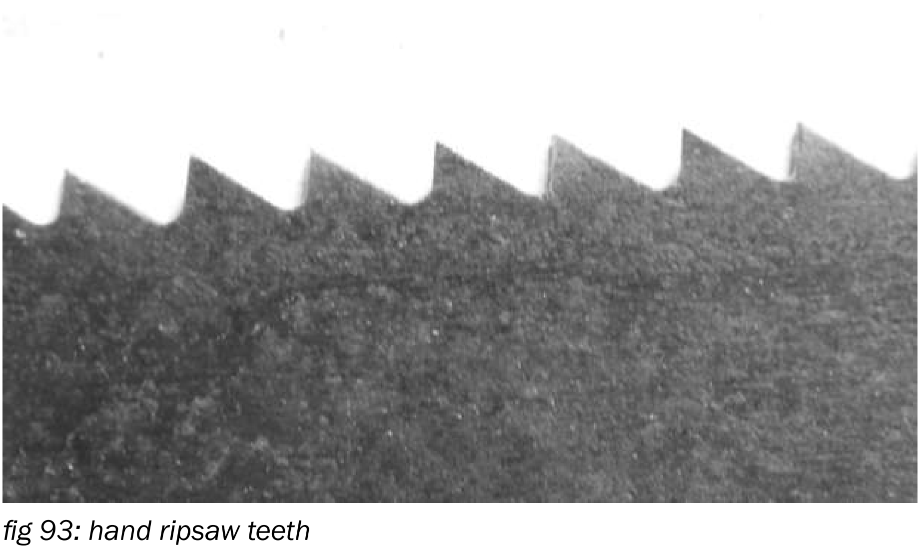


fig 93: hand ripsaw teeth

When working on site my mate used to borrow it frequently as it was ideal for ripping down the last floorboard next to the wall. From ripping the timber down to a nominal size we then used a jack plane, winding sticks and a set square to produce a planed face and edge on the timber. A jack plane is about fourteen inches long and the iron is sharpened with a slight radius across the cutting edge that gives easier use when dealing with sawn material, see fig 91.

Winding (rhymes with mind) sticks are two identical pieces of timber (normally beech) that are laid each end of a planed surface to indicate whether the timber has any wind or twist in it. You simply sight between the two to see if the top edges are parallel. Fig 94 shows these in position, but for correct use the eye would look over the nearest and sight the top of the other. Both sticks should look parallel, and if there is any discrepancy between what should be two parallel winding sticks, then a further wipe with the plane should sort this out.

fig 94: winding sticks

It is desirable to plane the timber as level as possible along the length and this can be checked with a straight edge. The most important parts are where any joints will be cut. If these parts are winding (twisted) then any mortices or tenons will be out of line and any joinery will be twisted once put together. Once the two faces are correct then they should be marked so that any further marking out should be taken from these faces to prevent any error being compounded. Hand planing some timbers can be difficult due to curly or uneven grain that will pick up and create rough areas, for instance red cedar and elm, but pines, poplar, sycamore and good oak are fine. Good quality timber is fine but knotty rough stuff is difficult.

Once a flat side has been created then the next operation is to square the edge. This again is done with the jack plane or, if it is particularly important, the tri plane (this has a longer bed). The edge is checked for square with a set square, and again the most critical parts are those where the joints are to be cut. You could, if the fancy took you, have the timber going anywhere it chose between the joints, as long as the joints are correct, square and parallel.

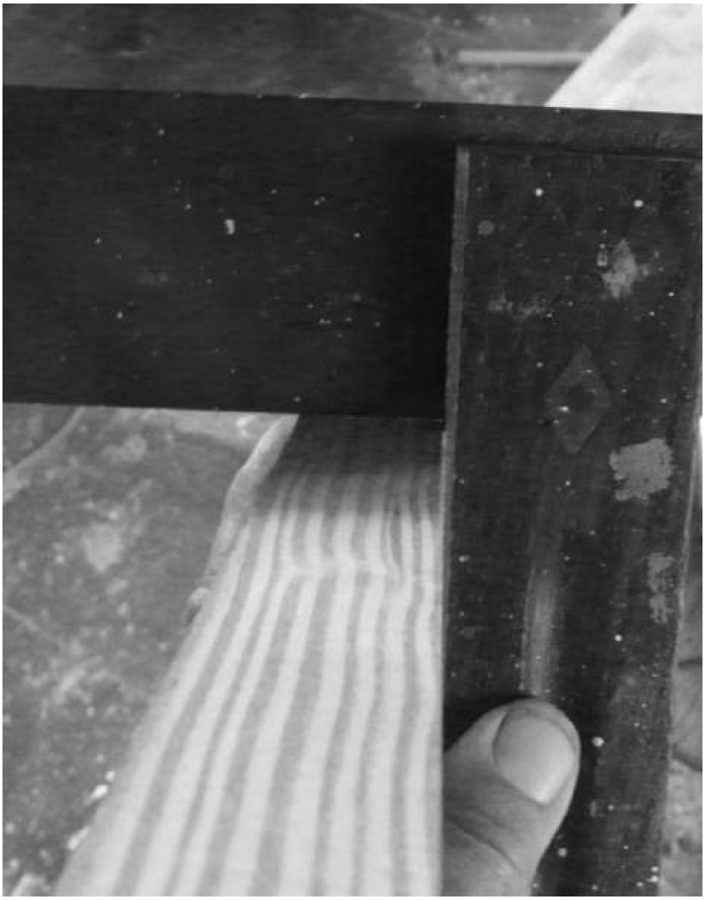


fig 95: checking for square

So, having set a face and edge that is planed and square then the other two sides of the timber need to be thicknessed (sawn and planed down to a desired and regular thickness) and finished. This is not always the case as it is not truly necessary where the other side of the timber is hidden. Hand-planed floorboards were traditionally only planed on the upper face. On laying the floorboards the carpenter would notch the back of the board to take account of any irregularities in either the board or the joist, so as to create a flat board surface.

A marking gauge is used to produce a regularly dimensioned piece of timber, marking from the faces the have been trued up; from the face and edge. This involves setting the marking gauge to the desired dimension and then marking all the way round the timber from the correct face. Running a pencil around the scratch produced by the gauge makes it easier to see.

fig 96: marking gauge

Now this all takes time to describe but once you have learned the skills it becomes natural to work from the side and edge and you realise that the thickness in most cases does not have to be thousandth of an inch perfect.

So the next part of this process is to plane down the back face that needs to be thicknessed with your plane laid at a slight angle towards the outside face of the timber until you just break through to the gauge line. This leaves a crown on the face with a raised section in the middle, see fig 97.

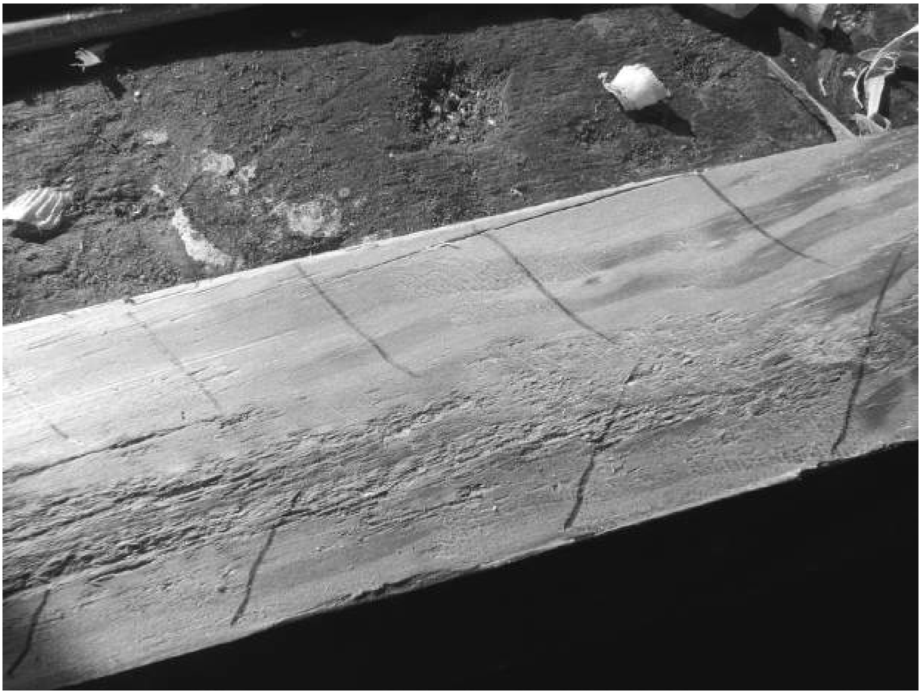


fig 97: thickness guide lines

The pencil marks shown in the photo are guide lines to help to plane the timber down to the correct thickness as they are drawn from the raised crown of the board to the edge. The face is planed down and as the pencil lines disappear this gives a guide as to how close you are getting to the correct dimension. This process is then repeated for the other timber dimension. It all sounds more complicated than it is, which is normal for a description of a learned hand-eye skill.

mechanical methods

The breakdown or resawing of dried timber is best done with a saw that has a finer and more accurate cut than that used for the initial conversion. The kerf does not need to be as wide as many of the examples shown in the *conversion methods* chapter, page 79. The quality of the cut required and the volume of timber to be cut dictates the machinery used. An upright static band saw can be used with a wide band for straight line accuracy and is desirable if a large volume is to be resawed. These saws have a movable fence for setting the width of the finished timber and can be used with a power feed to feed the timber through at an even rate to give an effortless even finish. A power feed is essential if feather edge cladding is being cut as the power feed gives even side pressure and therefore produces a very even product. However for a small joiner's shop a dimension saw is perhaps better, in that it is a multi-purpose machine and when used with a carbide tipped circular-saw blade gives a much better finish.

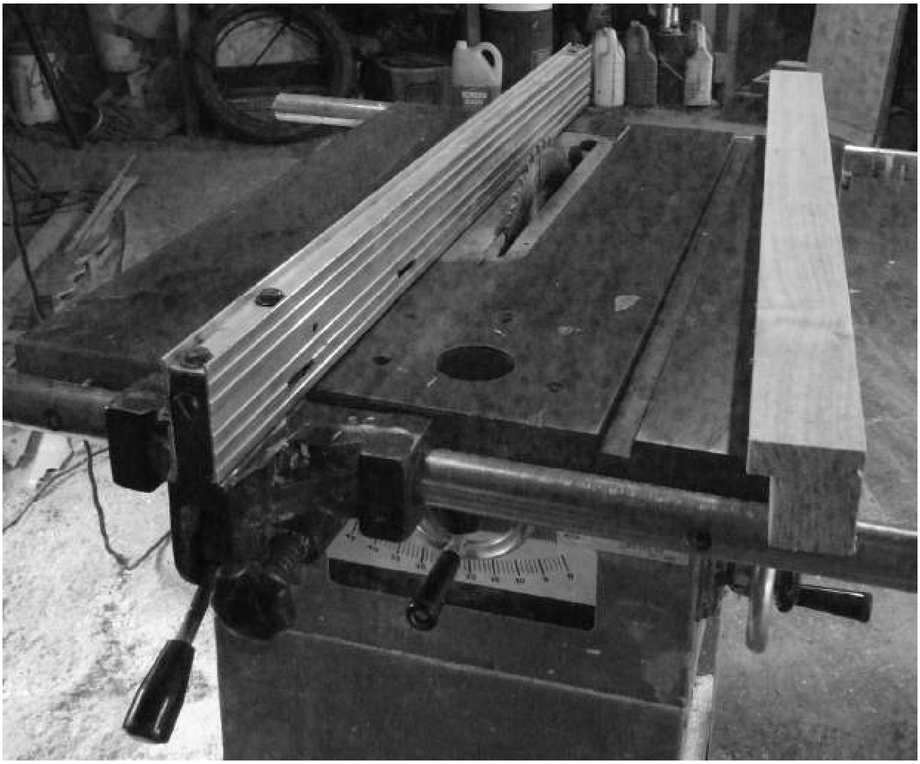


fig 98: dimension saw

The combination of an adjustable fence and a rise and fall blade means this saw can also be used for producing rebates in timber for things like window frames. A tilting blade allows angles to be cut, for instance when machining the slopes on window cills as we call them in the trade (sills).

fig 99: rebate cutting

The production of a planed face and edge similar to those produced with a jack plane can be machined with a powered planer. These machines are floor mounted and have a pair of wide blades mounted horizontally in a cylindrical block. This is then spun at high rpm to produce a planed surface. The two inch screw in the photo is there to give some sort of scale.

On either side of the cutter block there are wide and flat surfaces (tables) from which to work and make the planer usable. Both tables are adjustable for height from the cutter block and the rear table is set to the height of the cutters so the timber will move evenly from the cutter and be supported on the rear table. The front table sets the depth of cut by being set below the height of the cutters and the lower it is set the more material

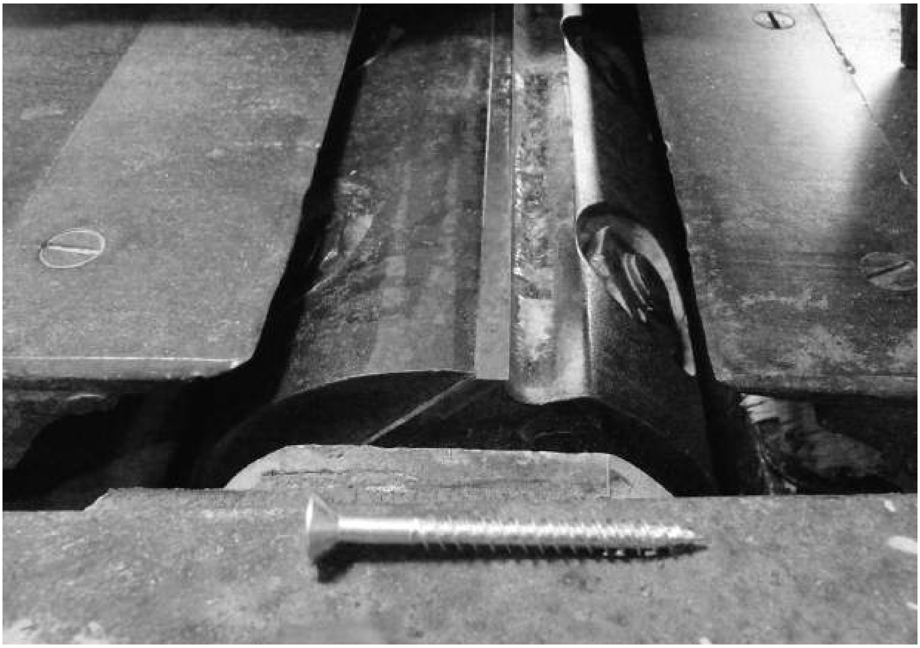


fig 100: planer blade

is removed in each pass of the timber. The photo shows my old Westgate Grafton machine, made in 1960 (which I was about to say was not that old) that's over 50 years but not old for good machinery. It is a planer-thicknesser, which means that timber can be surfaced over the top to produce a face and an edge, and then fed through underneath powered by driven feed rollers to machine the other faces to a pre-set thickness. The blades need to have a razor sharp edge and both cutting edges need to be exactly aligned to produce a smooth, perfectly planed surface.

basic machining method

When preparing timber for a joinery project the first thing to do is to re-saw stock timber into approximate dimensions allowing about 10mm extra on width and height to allow for surfacing and thicknessing.

Having done this then cut the various sections to length so that it is possible to surface plane them for side and edge. It is not possible to face and edge long lengths, so cutting to length first ensures accuracy.

Care must be taken when surface planing; firstly to keep all your finger ends and secondly to make sure you plane the widest face first to help with

fig 101: planer

accurate planing of the edge. This can be checked with a straight edge and winding sticks. Planing the matching edge is where many people go wrong, in that the previously planed face must be squared up to the planer fence even if the timber is not square with the planer bed. The idea is to produce a true square corner between two faces so it is important to know which datum face you are working off.

These two faces must be marked as face and edge so that any further squaring, machining or marking are worked from these faces. At this point you can use either of two methods to complete the dimensioning. The first one would be to use the thicknesser on your planer if you have one. Some planers will only cut over the top surface and have no thicknessing capability and so the second method will be needed.

This is to set the fence of the dimension saw and then, with the planed side and edge working against the fence and saw table, cut the other sides to size. This is again another example where working from the datum side and edge is important to produce square and even timber sections. The use of a tungsten carbide tipped blade makes a difference here as, due to the nature of the cutting edges, they produce a surface that only needs a light sanding for finishing.

sharp things and dangerous machinery

I wanted to use this as a sub-title for the book but was outvoted. However the thought is an important one and I say this from personal experience. Here are my recommendations:

- Use the correct guards on machinery that is well maintained and set up correctly.
- Keep fingers as far away from cutting edges as possible and use appropriate PPE (personal protective equipment) especially hearing and eyes.
- When using a dimension saw use a push stick to push the timber though the last bit, and adjust the rise and fall on the blade to suit the thickness of the timber. That way the minimum amount of blade is exposed and the maximum number of teeth is cutting the wood at any one point.
- When using a planer move the adjustable fence over so that the minimum width of cutter block is exposed. I lost a bit of finger because of this issue and the problem is not only the pain and suffering but also the recovery period where that simple mistake sets you back months and makes everything a struggle.

reflections

It took me decades to get to the point where experience and confidence means that I can build and not be worried about mistakes. I have learnt many things through trial and error, and through mistakes. I suppose we all make some mistakes but the skill is in recognising them and finding ways round them; it's having the confidence to let yourself take a bit of down-time to mull it over. However mistakes seem to come from thinking about too many things, so being in the moment and focusing totally on the job in hand seems to be half way to the answer, that and keeping all your fingers.

I still find that using local timber is very satisfying and the whole tree-to-finished-product experience is fascinating, and in some way grounds you with the environment and the passing time. I provided the eulogy at a friend's funeral a few years ago; he was a carpenter and joiner almost from another time. He was apprenticed in one of those old village carpenter and building workshops, where they did everything including making coffins and doing the burying. At the time I put forward the idea that my friend was part of a history connecting timber with skill and the landscape that included buildings made by craftsmen; a whole line of timber people stretching back into history, and passing the skills on to each new generation into the future. It is indeed reassuring that there are people willing to dedicate their time to learning and practising the ways of timber people, carpenters and joiners. It is not only a way of earning a living but, as with all consuming interests, a way of living.

It is important to keep time at arms length to be able to practise these skills, but time seems to go so fast; here, in September, it seems that it was January last week, but it has been so busy. I suppose packing eight months into a week would make things seem so.

As to the questions posed early in the book, I hope they have been answered, but just to be safe. Corsican pine more often than not has spiral grain, and so wide boards will develop a twist and will wind (rhymes with mind) when they are dried, making the boards useless and the wider they are the worse it gets.

Sweet chestnut grown on a sandy heath land will develop ring shake when it gets above about two to three feet in diameter due to moisture gradients in the stem as discussed but it does however naturally split (or cleave) easily and it is this property that makes it ideal for making roofing shingles, that and the fact that the heartwood is durable.

To quote V. Stanshall, 'Sometimes you just can't win'. And I suppose the skill is in knowing when to modify methods and material to suit the job in hand.

resources

Youtube: Andy Reynolds
The author's information channel
http://www.youtube.com/watch?v=Nx6UKeZIsvc

lowimpact.org/trees

lowimpact.org/timber

lowimpact.org/chainsaws

These resources are constantly being added to and amended.

Here are a number or websites and books recommended by the author:

websites

ASCIA
Traditional and sustainable craftsmen in mud and wood
01754 890688

Bailey's Outdoor Power
www.Baileysonline,com

band saw details
http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2513/NREM-5046web.pdf

board foot
http://www.woodweb.com/knowledge_base/What_is_a_Board_Foot.html

felling licence details
http://www.forestry.gov.uk/forestry/infd-6dfk86

Foresty Commission grants and licences website
http://www.forestry.gov.uk/forestry/infd-6dfk2u

Hud-son sawmills
www.hud-son.com/

Just Saws
www.justsaws.eu

Logosol; portable sawmills
www.logosol.com

measurement of timber
http://www.timbermeasure.com/CDA_2012/1-Atterbury.pdf

National Biodiversity Network
http://data.nbn.org.uk/

Peterson sawmills
www.petersonsawmills.com

Procut sawmills
www.procutportablesawmills.com

The Royal Forestry Society
http://www.rfs.org.uk/about/about-us

The Small Woods Association
http://smallwoods.org.uk/

Wazel wood floors
Floor manufactures, sawmillers, providers of fresh, air-dried and kiln dried timber
http://www.wazel.co.uk/

books

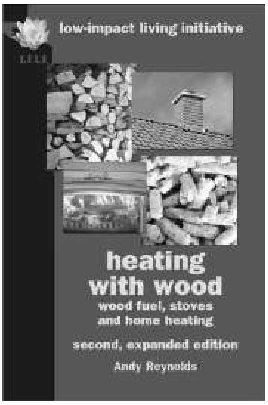
Tall Trees and Tough Men
Robert E Pike
A history of timber and river driving in New England
W.W. Norton and Co.
ISBN 0 393 31971 2

Forest Mensuration, a handbook for practitioners
RW Mathews & ED Machie
ISBN 9780 85538 621 4
available from: http://www.landmarktrading.com/

Decimal Hoppus Tables
SE Wilson
Stobart Davies Ltd
ISBN 0 85442 003 7

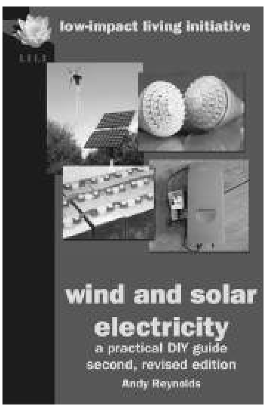
Forestry
T A Robbie
Teach yourself books
English University Press Ltd. 1955.

other lowimpact.org books



Learn how to heat your space and water using a renewable, carbon-neutral resource – wood.

This book includes everything you need to know, from planning your system, choosing, sizing, installing and making a stove, chainsaw use, basic forestry, health and safety, chimneys, pellet and woodchip stoves. The second edition has been expanded to reflect improvements in wood-fuelled appliances and the author's own experience of installing and using an automatic biomass system.

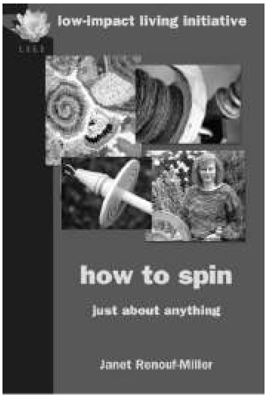


The author has been providing his own electricity from the sun and the wind for many years and in the first edition of *wind and solar electricity* he shared his knowledge and experience.

Developments in the associated technology and UK government incentives have led him to make substantial revisions and additions, including new illustrations and photographs, for this second edition. He provides practical, hands-on advice on all aspects of setting up and keeping a home-generation system running from his recent experience.

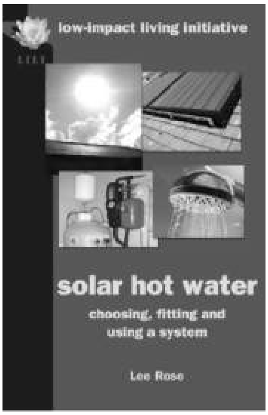
The author grew up in Jamaica and was taught to make soaps by her grandmother. They grew all the plants they needed to scent and colour their soaps and even used wood ash from the stove to make caustic potash.

Her book is intended for beginners, includes both hot- and cold-process soap making, with careful step-by-step instructions, extensive bar, liquid and cream soap recipes, full details of equipment, a rebatching chapter and information on the legislation and regulations for selling soap.



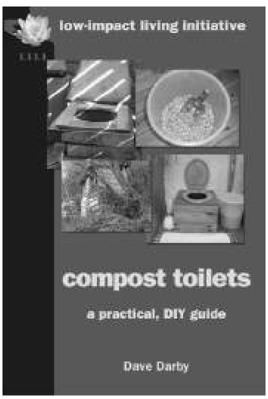
how to spin: just about anything **is a wide-ranging introduction to an ancient craft which has very contemporary applications.**

It tells you all you need to know about the available tools, from hand spindles to spinning wheels, what to do to start spinning, has illustrated, step-by-step instructions, and a comprehensive guide to the many fibres you can use to make beautiful yarns. The author is a registered teacher with the Association of Weavers, Spinners and Dyers.



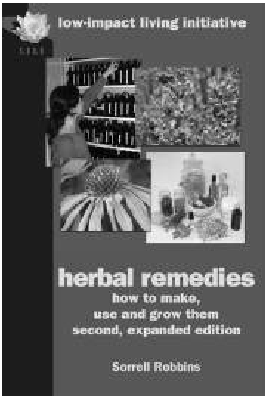
solar hot water: choosing, fitting and using a system **provides detailed information about solar-heated water systems and is particularly applicable to domestic dwellings in the UK.**

Lee Rose has ten years of experience and involvement in every aspect of the solar thermal industry in the UK and around the world. His book provides a comprehensive introduction to every aspect of solar hot water: including all relevant equipment, components, system design and installation and even how to build your own solar panels.



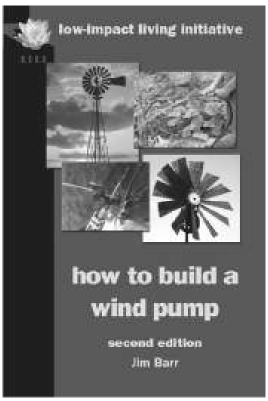
Compost toilets reduce water usage, prevent pollution and produce fertiliser from a waste product. Built properly they can be attractive, family friendly and low maintenance.

This DIY guide contains everything you need to know about building a compost toilet, proprietary models, decomposition, pathogens and hygiene, use and maintenance, environmental benefits, troubleshooting and further resources.



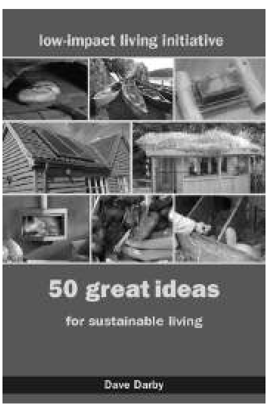
herbal remedies: how to make, use and grow them **teaches you to identify, grow and harvest medicinal plants.**

It shows you how to make a range of simple medicines; there are sections on body systems, explaining which herbs are useful for a range of ailments, and detailed herb monographs. This second edition has been revised to take account of recent changes in UK legislation. Sorrell Robbins is a highly-qualified, leading expert in natural health with over 15 years experience.



Good for developed or developing countries, the wind pump described in this book can pump rainwater, greywater, river, pond or well water for irrigation, aerate a fish pond, run a water feature or even be a bird scarer.

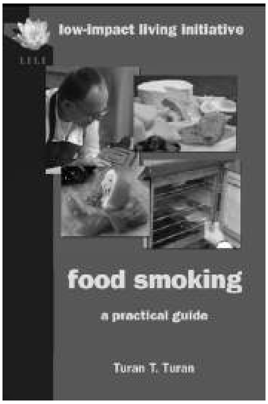
In a light-to-moderate wind it should pump about 1000 litres a day with a head of 4-5 metres. If you have good engineering skills and equipment you can fabricate nearly all of the system yourself; if you get all the parts manufactured, it's not much more complicated than DIY flatpack furniture.



Containing 50 practical ideas for ways that you can help to stem the tide of destruction that is overtaking the ecology of our one-and-only planet this book is a random selection from the topics on our website selected from these categories:

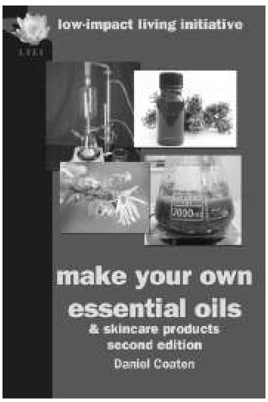
- shelter
- land
- lifestyle
- food & drink

Each topic is then divided into three sections:
what is it? what are the benefits? what can I do?



Back in our cave-dwelling days, food smoking was used to preserve food and then our ancestors discovered just how great it makes food taste.

Turan T. Turan has been a passionate smoker of food for many years, teaches courses all around UK and now crystallises his knowledge in *food smoking: a practical guide*. He simplifies and demystifies the process of smoking food to enable you to produce wonderful smoked food in a sustainable, eco-friendly way. Enjoy!



There are many books available on using essential oils – this one helps you to make your own.

Making your own essential oils can be a fascinating hobby or, for the professional aromatherapist, a way of ensuring that your products are fresh, unadulterated and organic. Our book also describes how to make creams, lotions, balms, gels, tinctures and other skin-care products from the essential oils and distillate waters you have produced.

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